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BRITAIN AWAITS THE BLITZKRIEG

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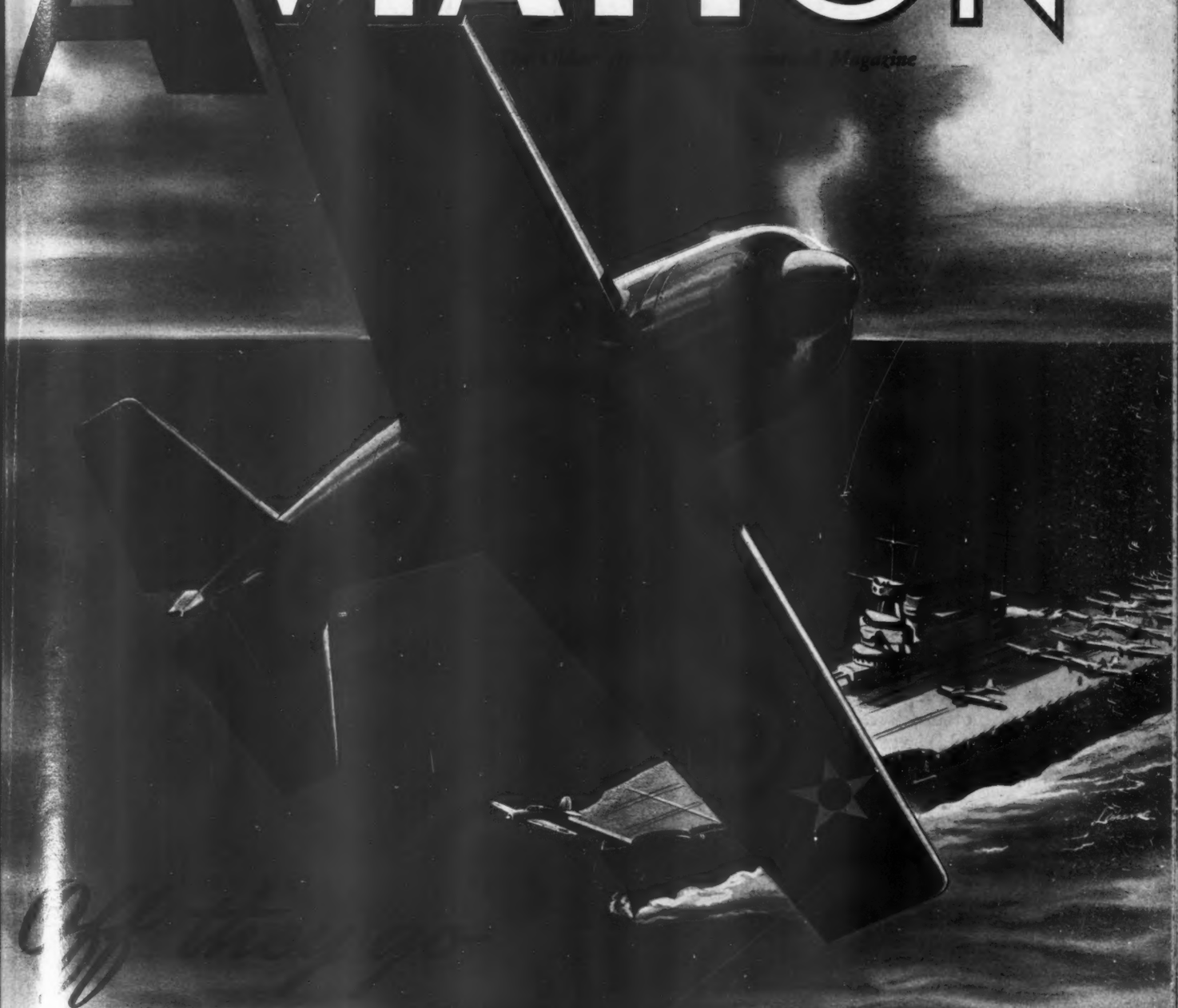
AVIATION

Magazine



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AVIATION

Established 1916

OLDEST AMERICAN AERONAUTICAL MAGAZINE

THIS MONTH celebrates 15th Anniversary of Western Air Express. This shows Harris Hanshue, 1st president, handing 1st sack of mail to Fred Kelly, 1st WAE employee.

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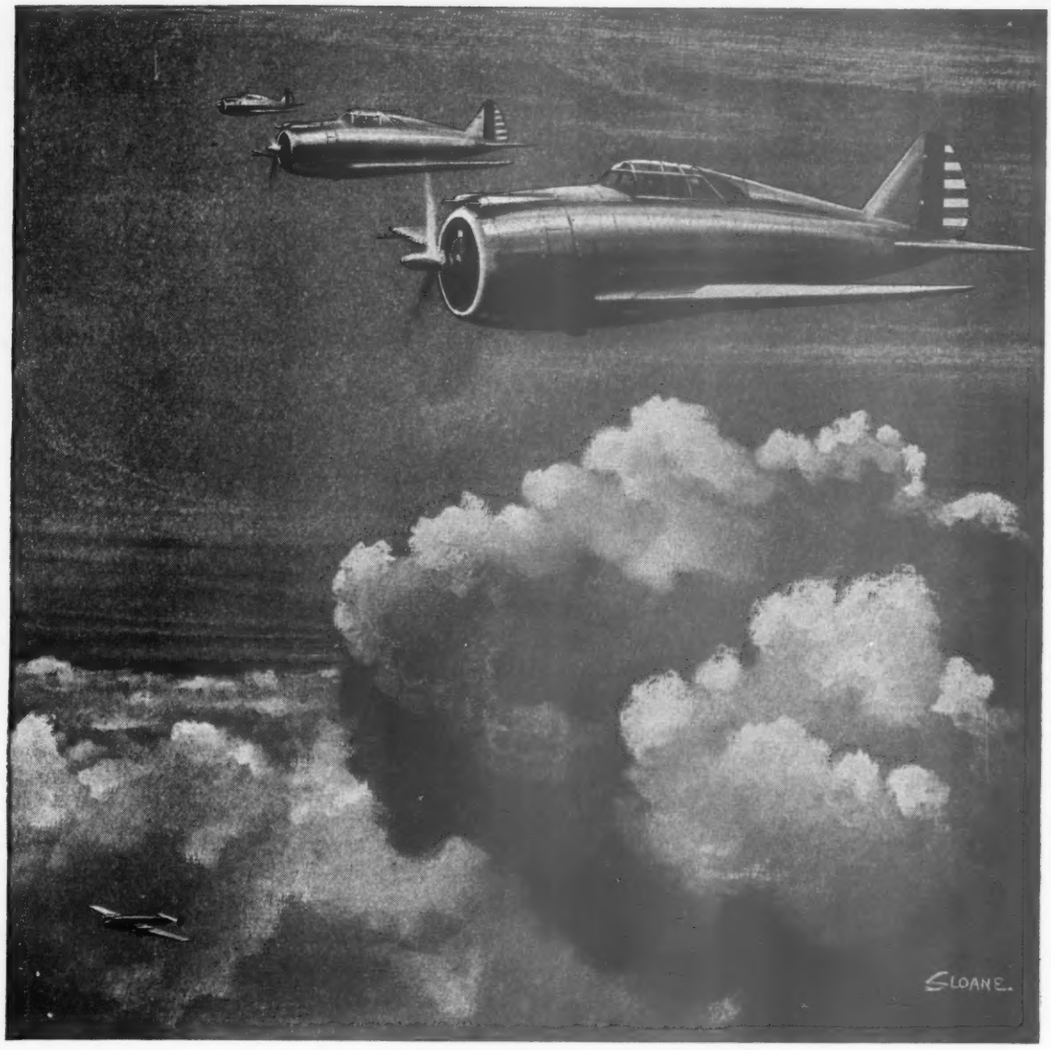

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IN COMMAND "UP THERE". . . In the thin, cold air at 30,000 feet and over, Republic Aviation interceptors meet every challenge. Designed, built and supercharged for maximum military utility to counter high-altitude bombardment, these Republic Aviation pursuit planes will equip many squadrons in the powerful and rapidly expanding fighting forces of the United States Army Air Corps.

REPUBLIC AVIATION

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Still More Manufacturing Expansion in Sight

« STILL GREATER EXPANSION of the aircraft industry appears to be inevitable. No one knows exactly how far it will go. Programs are being made and remade. Officials of the Army, Navy, and O.P.M. are conferring daily and working out details at night with almost daily breakfast and dinner conferences to keep up with the President's requests for more and more airplanes for the British and for ourselves. The new programs are intended to take hold when the present one winds up in the middle of 1942. At the moment the course is fairly well charted to the middle of 1943 but actual numbers are confidential. It can be said, however, that they are greater than most of us dared to believe.

« SHORTAGES, DESIGN CHANGES, AND LABOR TROUBLE continue to retard the progress of the present program. In spite of these obstacles, the total Army, Navy and British production figures for February coincide closely with the prediction published in AVIATION for January (The Truth About the Defense Program, by T. P. Wright.)

Curtiss-Wright, North American, Stearman, and Vultee are continuing their outstanding production performance. The latter completed its initial contract for 300 basic trainers almost two months ahead of schedule in spite of the recent strike. Consolidated is turning out PBY Patrol Boats and B-24 Bombers for the Army, Navy, and British as well as huge PB2Ys for the Navy at a very satisfactory rate. Bell has been hitting its production stride but is hampered on deliveries by a momentary shortage of the particular model of engine required for the P-39. February engine production exceeded expectations on present types, but one manufacturer experienced some difficulty in changing over to an advanced design. Although design changes will always take their toll in production performance, it is extremely fortunate that our program is set up so that improvements may be introduced along the way. A rigid adherence to fixed designs would be very dangerous. There are still a few rough spots, mostly because of design changes, and changeovers from one contract to another. On the whole the program is progressing satisfactorily but the best is none too good and we must spare no effort to squeeze every possible airplane, engine, and accessory off of the final assembly line.

» LABOR TROUBLE IS THREATENING in several vital spots as this is written. If it comes in these particular places it will play havoc with the fulfillment of the program. Regardless of the inalienable rights of workers or of management, loss of a single day or hour of production in these critical places will slow up many other manufacturers' output all along the line. If this time is lost it is not impossible that labor, management and everyone else will lose the better part of their inalienable rights for a long, long time to come. We must devise some means to settle differences between management and labor while production is going on.

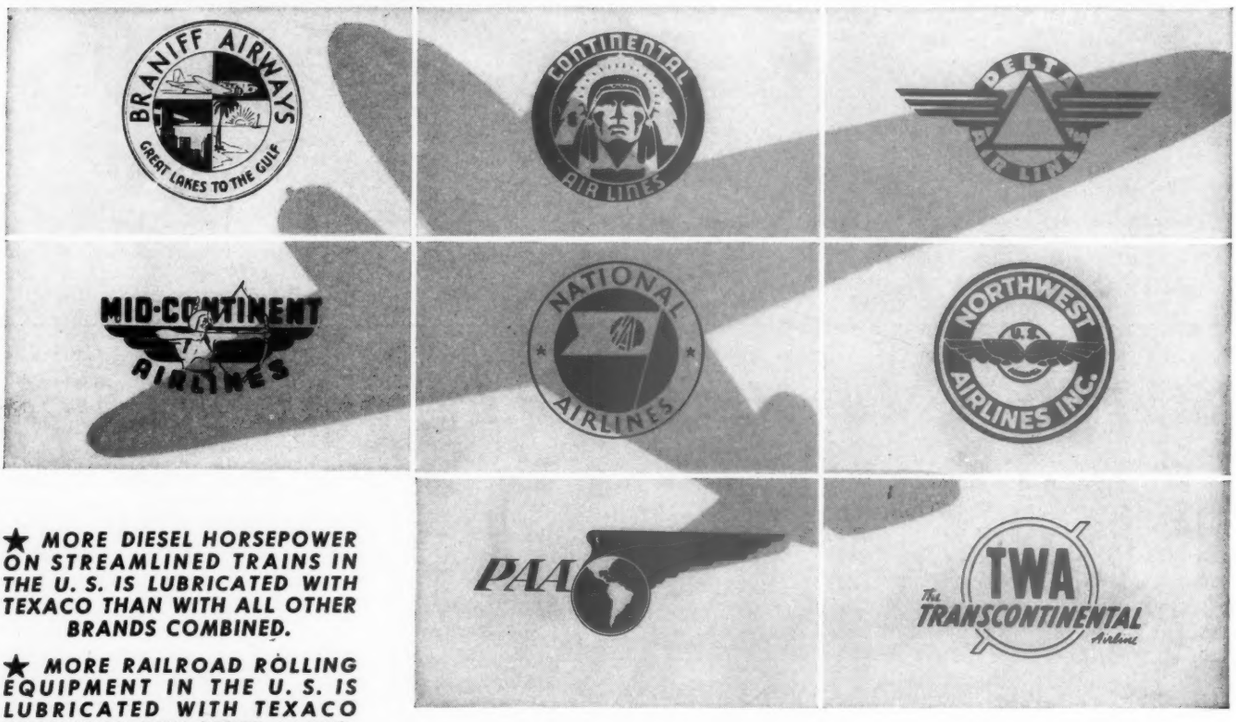
» WASHINGTON IS FULL OF ALUMINUM SEEKERS from many industries. All of them come down well armed with facts and figures to prove that they must have so many pounds or else something terrible is going to happen. Some of them are asking for more than they need. The Priorities Division of O.P.M. has a difficult job on its hands. In the military services there is a growing acceptance of the Civilian Training Program as a selection machine for candidates for military and naval training. It is hoped that the Priorities Division recognizes this fully and find ways and means to provide the light plane manufacturers with their infinitesmal needs even at the expense of non-defense industries.

» THERE WILL BE CRASHES far worse than any yet experienced if we fail to follow the rules of the airways. Recently we have had reliable reports of several close calls between airlines and military airplanes. The Army is totally unjustified in jeopardizing personnel and equipment, as well as civilian lives, by operating without properly filed flight plans. Such operation is *not* in the interest of national defense.

» THE AIRLINES SHOULD COOPERATE by decorating their ships in such a way that they are more readily visible and increasing the intensity of their flying lights at night. And it is high time that the 90 degree screening of wing lights, a hangover from marine practice, be modified to provide 180 degree screening so that flying lights may be visible over a much wider range. Increases in visibility of aircraft at night must keep up with increasing speeds.

There are times when conditions justify a change in flight plan. We have flown in airliners which darted in and out of clouds when there was perfect visibility 1000 feet above or below the

Eagles that keep Cost Records



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TEXACO Lubricants and Fuels
FOR THE AVIATION INDUSTRY

predetermined altitude. Not only because of the increasing congestion in the skies and the increasing risk of collision in the air, but for passenger comfort as well, it should be possible to alter a flight plan enroute with due notice to other aircraft in a given area.

« CONGRESS WILL NOT FIND, in the present investigation, any logical connection between the recent airline accidents and the reorganization of the Air Safety Board. It is extremely doubtful if Congress will find anything of value for this expenditure of the taxpayers' money. If the investigation is fairly conducted, and there are some early indications that it may be, it will be discovered that the recurrence of accidents after the reorganization was pure coincidence. There are epidemics of accidents in all varieties of transportation. These epidemics frequently are due to the overconfidence that builds up during long periods of perfect safety. Often they are due to careless habits developing from operating mistakes that have been repeated many times over without disastrous results. Then, suddenly, the mistake is made once too often. These human failures cannot be regulated out of existence. The airlines must work out their own salvation. And they can do it only by tightening up and increasing the alertness of everyone concerned with airline operation. And that means everyone from the boy who sweeps the hangar floor to the vice president in charge of operations.

» DESPITE THE ACCIDENTS, airline traffic for January was 25 percent ahead of the same month last year and February, 1941, was about 40 percent ahead of February, 1940. Much of this increase was due to the accelerated travel in connection with the defense program. The airlines are playing an important part in accelerating the increase in productive capacity for total defense. The military services, particularly the Army, should consider this carefully before moving to take over any additional transports from factory production lines.

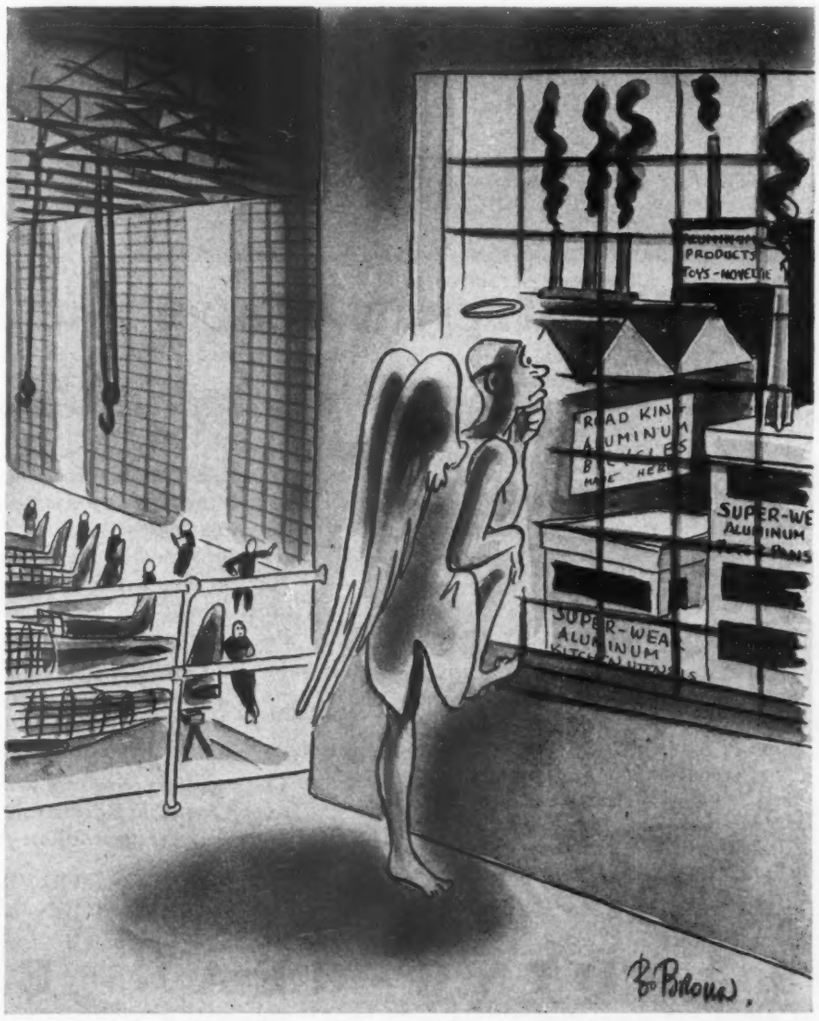
« IT IS TOO EARLY to appraise the results of the installment air travel plan instituted March 1 by seventeen of the leading airlines. This is a step we have advocated for some time. It should have been taken a long while ago. Installment purchasing has brought many conveniences and pleasures to the American public and has increased sales volume in many businesses. Without it the automotive industry and many others never would have approached their present proportions. Now it will bring airline travel to thousands of families who have wanted it but could not see their way to make the total outlay in advance. In so doing it will convert to airline travel many of that large and heretofore almost untouched groups of people who pay out of their own pockets for transportation because they cannot travel on expense accounts. And it will help to reduce the sales resistance of the wives and families of many men who travel on business, but have not been able to afford to demonstrate to their dependents the advantages and comforts of air travel.

» RAISING THE MINIMUMS for instrument approach was a wise step on the part of C.A.B. During the past few months we have experienced, in our own extensive airline travel, one or two landings that should not have been made. Until instrument landing equipment is available and is installed at terminal airports we must be content to accept some reduction in regularity in the interests of greater safety.

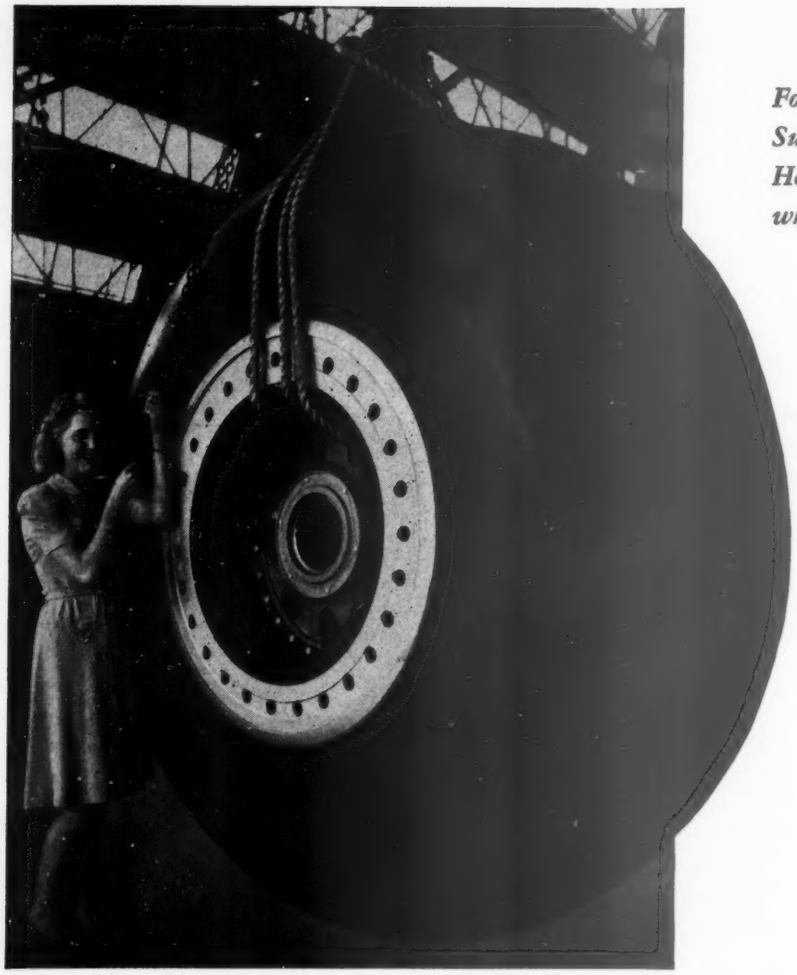
» THE ROYAL AIR FORCE Benevolent Fund of the U. S. Inc., a one-hundred-per-cent war charity with no deductions from receipts for overhead, has been founded here as a branch of the British Fund. Its sponsors, prominent business men and others headed by Colby M. Chester, chairman, and Thomas H. Beck, president, are underwriting all administrative expenses, and all donations are forwarded in full to England.

In the initial drive for funds the aid of the Aviation industry, operative and manufacturing, is being enlisted. Roger Wolfe Kahn, well-known aviation enthusiast, is heading up this activity. He has announced a "Hats off to the R.A.F." party at La Guardia Airport for April 29. A Piper Cub, donated by the maker, will be one of the prizes.

IT PAYS TO FLY



Maguire is waiting for the aluminum he ordered several months ago.



For the Great New Douglas B-19 Super-bomber, "Guardian of a Hemisphere". . . 2700 pounds of wheel, brake, tire and air!

The 50,000th* Bendix Aircraft Wheel and Brake assembly has just gone to work!

*AND 1,000 A MONTH FROM NOW ON!

We couldn't hold a recess for tea-and-crumpets when our people rolled the fifty-thousandth Bendix Aircraft Wheel and Brake assembly away from Final Test on St. Patrick's Day. The occasion was signalized by merely another check-mark on the day's production sheets. But somebody *did* pause to reflect . . . that 50,000 units is a lot of experience with any product . . . and how the Pace of Experience has accelerated!

In foreign skies men are cramming into 24 hours the equivalent of years of peacetime military research. New knowledge comes almost daily to reinforce the painstakingly acquired data of a dozen years of research.

The steadfast trust of a group of very gallant men, who continue to call for what Bendix folk are building, who continue to accord our products their fullest confidence, is an inspiration indeed.

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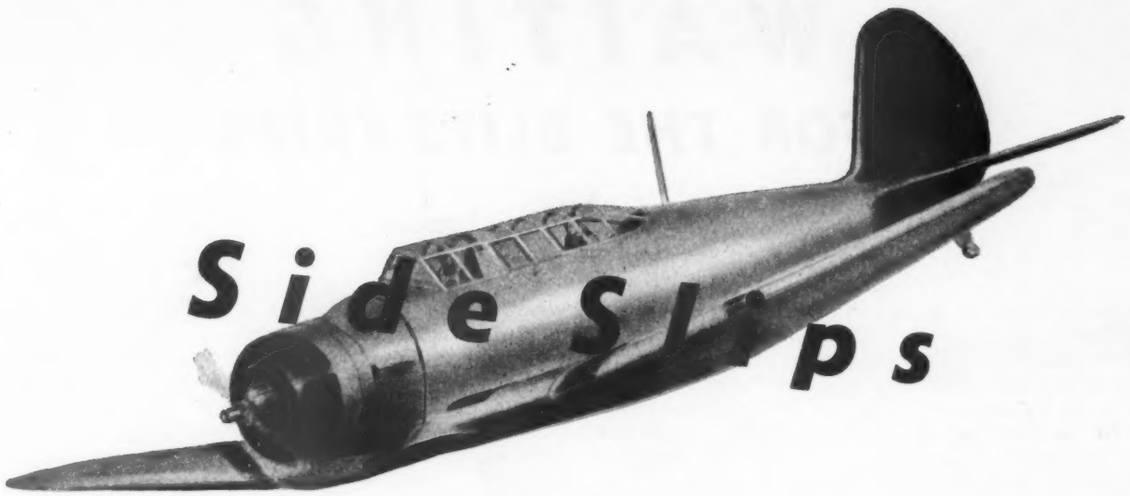
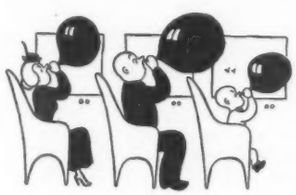
SWIVELABLE AND STEERABLE TAIL-KNUCKLES • PILOT SEATS



Side Slips

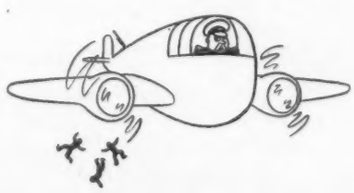
« DID ALL OF YOU READERS get one of Eastern Air Lines' "air conditioners" for your ears? It's a little balloon with a wooden nozzle that you blow up with your nose; opens up your Eustachian tubes, in case they're closed. The one we got was pretty stubborn and we didn't have enough diaphragm to inflate it, even though we used to be noted for our power on the cornet. We brooded over this for a day or two, and then took the ear conditioner home. Our wife watched while we again failed to blow it up. Seeing one of her rare opportunities to break our domineering spirit, she seized the device and put her whole soul into it. Her eyes stuck out and her face got as purple as huckle-



berry jam, but she won the round. The balloon got as big as an avacado, at least, and about the same shape. But our wife wasn't happy very long. Her head soon began to swim. That was several days ago, and she says her ears still feel as if she had climbed a high hill and stayed up there.

» NOW THAT THE WINTER IS OVER and gone and the voice of the turtle is heard again in the land, here is a little sub-zero operations story. Sitting in a DC-3 at La Guardia Field one bitter night last January, waiting to be flown home, we watched the port engine turn over, stiff as molasses, and fail to go. It failed in three or four more turns. Then out on the field came a man with what looked like a bamboo fish pole. It had a hand-pump fire extinguisher on the butt end, and a copper tube running up to the tip, where it curved over in a hook. He reached the hook into the carburetor intake vent, gave the extinguisher a couple of strokes, backed away, and engine started with alacrity. After we got up, we told the stewardess to go and ask the pilot what the man squirted into his intake. We thought sure it was going to be ether. She came back in a minute and said it was just raw gasoline. Looked pretty neat to us.

» ALL THIS TALK about people who want a lot of airplanes quick has brought out a sort of parable to illustrate what may happen. If it's been printed somewhere we defer to the author. It seems that a working General in somebody's air force demanded a fleet of special long-range bombers to do a job on an objective he had set his heart on. The manufacturer demurred; said mistakes were sure to result from such hurried delivery. The General demurred right back at him; told him to produce or else. On the appointed day the General got his bombers. He organized a mission and climbed into the lead ship himself. It was a beautiful job.



The whole squadron took off, and flew. Arrived over the target, the General himself reached for the bomb trip, gave it a pull, and the night crew fell out.

» THE OTHER DAY we asked an airline executive just what happens behind the insurance scenes when an operator has an accident with fatalities.

He said that of course the airlines have liability insurance. When there are casualties, the heirs and assigns invariably institute claims. Quite often a settlement out of court is reached between them and the insurance firms.

The airlines take out personal liability coverage with insurance companies just as do railroads, bus lines, and steamship companies. Very few suits are instituted as the policy has been for the insurance company to make fair and prompt settlements.

Incidentally, while the public does not recognize how safe air transportation has become when measured in terms of passenger miles despite the prominence given any airplane accident, one proof of this is the action of one underwriting firm in New York offering a policy in thousand dollar multiples at $1.10 a thousand per year, which permits a passsenger to fly 24 hours a day if he wants to on any scheduled airline. In other words, this policy, on payment of $5.50 per year, would give the holder $5,000 protection even if he flew 365 days a year. Furthermore, in recent months fourteen insurance companies have eliminated previous penalties which were imposed on air travelers in their life insurance policies, and these fourteen companies now write life insurance for air travelers on scheduled airlines without any extra premium.

Incidentally, those little $5,000 travel policies you buy for two bits are a popular item. A checkup on an accident in which a number of persons were lost, showed that all but one of them had those policies. The benefits are not, of course, deductable from the liability of the operators' underwriter.

WAITING
FOR THE BLITZKRIEG

A Letter from London

THINGS here are going very well. Output is going up like blazes, particularly because, thanks to bad weather, we have had practically no interference with work on our night shifts for the past two months. But even if there had been, the output is jumping.

Naturally, we are all sitting and waiting to see what the newest sort of blitz is going to be. People talk gaily about 4-ton bombs,—which might be nasty if they hit anything, but would be a frightful waste of material and carriage if they do not.

With a 4-tonner you have either got to hit something or waste it. You cannot spread it lengthwise or crosswise over a target area as you can a stick of bombs.

Also, quite naturally, there is a lot of talk about gas attacks. But judging from the little I know about gas, they can only be of a limited extent. They might be used in an attempt to terrorize the civil population in the same way that machine-gunning the streets, or flying alongside railway trains and pumping bullets into them is an attempt at terrorization. But I do not see how any sort of aeroplane is going to carry enough gas or gassifying liquid to cover a big enough area to have any serious effect.

And, to be at its worst, gas needs an absolute flat calm to be effective. Thank the Lord this is a windy country. People who live in Central Europe are apt to forget it, and I can see gas attackers leaving Germany on what they fondly imagine to be a flat calm day and running into half a gale here. But probably they have discovered that in the course of their raids.

I think that what the bulk of the population of this country are looking forward to is the promised invasion. They are not exactly viewing the prospect with pleasure, as they know that somebody is going to be discommoded. But they want it to come and get it over. The mental attitude of the nation as a whole is rather that of somebody who is about to take some unpleasant medicine which he feels absolutely confident will do him good when he has got rid of it.

The Air Force naturally are looking forward to it with something very like pleasure, because they know it will give them the chance of a thundering good whack, not only at the German Air Force, but at the stuff on the sea and at anything which may perhaps survive to reach the coast. And they are anxious to see what will happen if the Germans try to put down troop-carriers and the much-advertised trains of gliders in this country.

Personally, I cannot see how they are going to do it in the dark, and if they try it in the daytime, they have not got a hope.

If they try parachute troops, there are so many soldiers all over the country, and there is such a lot of the Home Guard, and they are all so keen, that I cannot see the parachutists having a hope either.

Even if the Germans launched an attack with a million men all at once, and even if they tried to concentrate them in a few areas. I still do not see how they could do more than possibly break up a few railways or burn an aerodrome or two.

And another thing, for the purposes of tackling them, all the obsolete fighters in the country and those few American fighters which would be considered under-armed for first-class fighting on the Continent, would come in perfectly well. In fact, even elementary trainers could carry enough bombs to do considerable execution among boats off the coast and men trying to land on beaches.

It is likely to be a grand scrap if and when it comes.

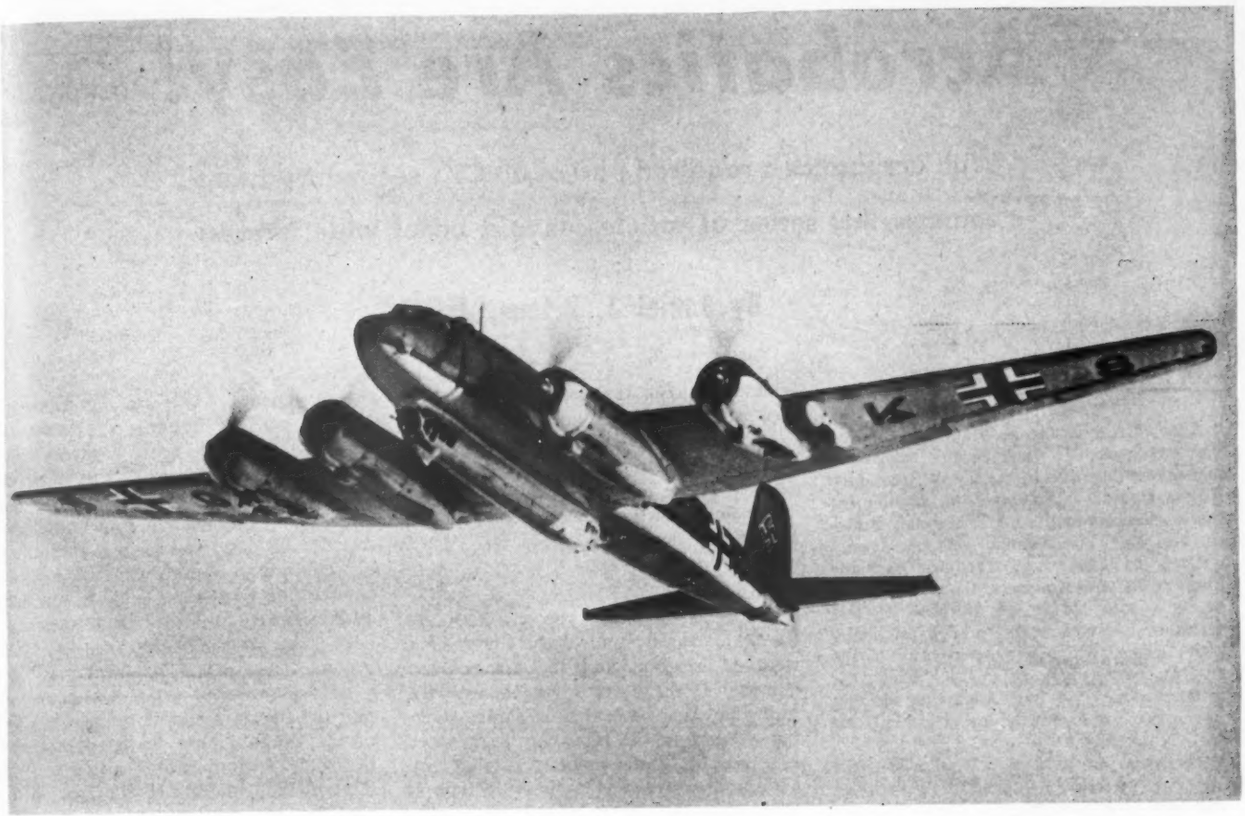
I do not think that there is anything in this letter to which the Censor is likely to object, so just use anything you like.

Yours very sincerely,
C. G. Grey

At top of facing page is the German Focke-Wulf Courier. This long-range, four-engine bomber may be one of the new types of Nazi planes which will be used against Britain this spring. Note the unusual bomb bay. Below: London before the blitz.

Britain is waiting eagerly for the Boeing Flying Fortresses whose long range permits them to fly from England to all parts of Europe with a real load of bombs. These are B-17-D's in Seattle ready for England.

Wide W



Acme

Wide World

Acrobatics Are Easy!

With acrobatics a required part of all CPT secondary flight courses, this series of articles should be of wide interest

By Daniel J. Brimm, Jr.

Part I

Acrobatic flying is no longer considered the execution of the various acrobatic maneuvers required in the CAA Secondary Flight Course is intended to supplement the discussions in the CPT Manual, Bulletin No. 23. The Manual was necessarily written to cover any type of airplane likely to be used and hence is quite general in its scope. It is the purpose of this series to be specific and to disclose many little "kinks" which will be of value to the student, particularly in schools where the instructors are so busy that they do not have time for as much verbal explanation as they would like to give. Furthermore, since a large number of operators—the majority perhaps—use the Waco trainers, the instructions following apply particularly to that general type. The sequence of maneuvers is slightly different from that in the CAA Manual, and one exercise is introduced because of its marked value.

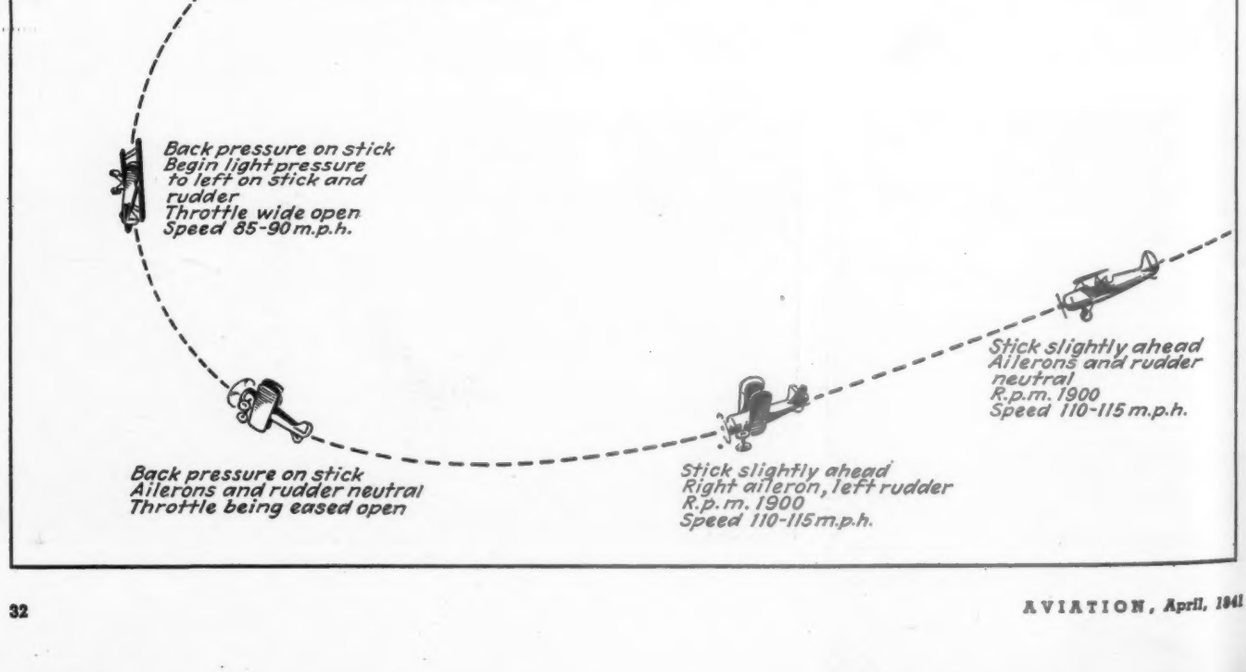
Author's Note: This series of articles on "stunting." On the contrary, acrobatics give valuable training and when properly executed in suitable aircraft are easy, safe, and a lot of fun. Follow the procedure outlined below and you'll find them so.

But *don't* start without a competent instructor or check pilot!

LET'S assume that you are about to take your first acrobatic flight. The weather is good and the air not too bumpy. If there are severe bumps, the flight had best be postponed, since striking a bump at the relatively high speed required for some maneuvers may impose undue stresses on the structure of your ship. At best, rough air makes precision acrobatics much more difficult, and precision is what we are shooting at. Almost any kind of ham pilot can take a husky and reasonably high-powered ship and wallow through most of the maneuvers. We are not interested in that kind of flying. We want our loops to be true, with recovery back through the slipstream of the start, our slow rolls made with the nose held on one spot on the horizon, our Immelmans exactly 180 deg., and so on. In addition to reasonably smooth air, there should be a ceiling of at least 4,000 ft. and little or no haze. Unless you have a horizon—at first, anyway—you are going to become badly balled up.

Before you put your parachute on, pull the packer's card from the top side of the 'chute (the side in contact with the seat of your pants) and check the last packing date. If it's not within the last 60 days, get another 'chute. You probably won't need it, but if you do, you'll need it badly. There's no use wearing it if it isn't fit to use. Make this inspection a habit, unless you have your own private outfit. Try the

Fig. 1. The Chandelle



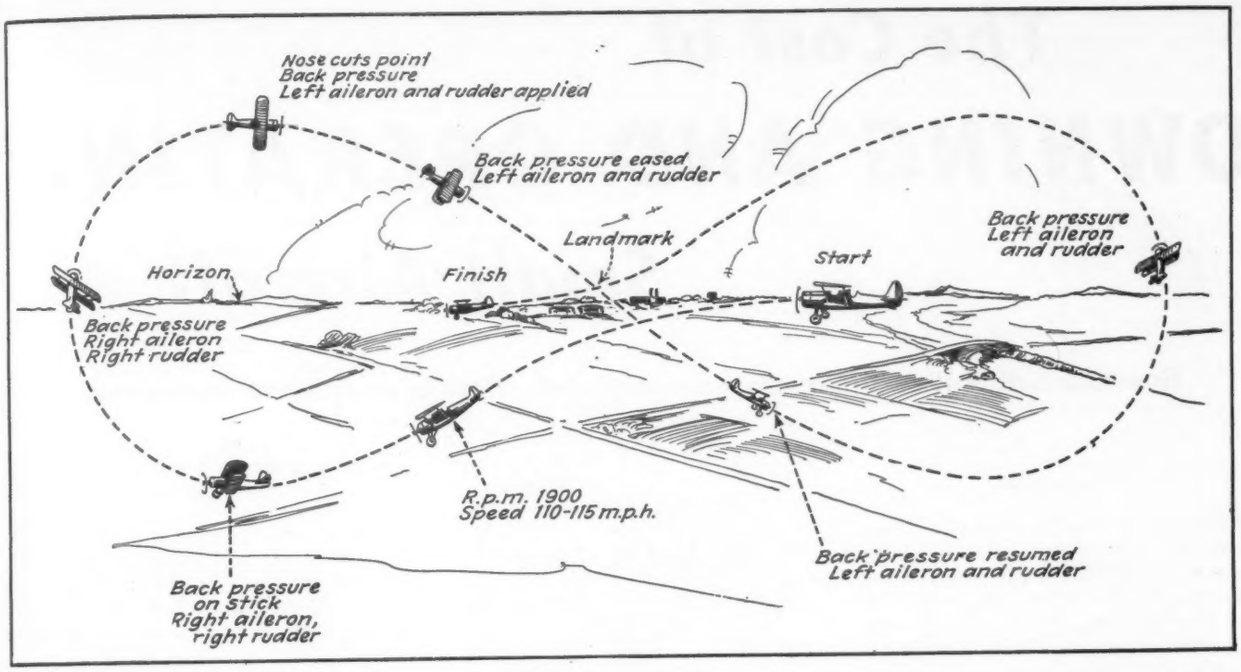


Fig. 2. The Lazy Eight

parachute on. If the fit is too loose in the chest, the harness may be taken up at the fitting on the top of the shoulders. However, looseness here is unimportant. What *is* important is the fit of the leg straps. These should be adjusted as tightly as possible while you are sitting on the pack in the normal position. Then unbuckle the straps, since you cannot walk comfortably if they are properly tightened. If they are too loose and you have to use the 'chute, you will get a nasty jerk and very uncomfortable support on the way down. If the straps are snug you will sit in the harness as in a chair.

It is assumed that by the time you have reached this stage of your flying career, you have formed the habit of inspecting the ship before flight; accordingly, this important job will not be discussed here.

Carry your 'chute to the ship under your arm or by the leg straps—it's easier than wearing it. Put it on, leaving the leg straps unbuckled, and climb in. Buckle the leg straps and your safety belt. Now—and this is *most important*—put your feet on the rudder pedals and pull each of the four safety belt adjusting straps as tightly as possible, then tighten them some more. If you don't you'll wish you had, when you start your slow rolls and half rolls, or even Cuban Eights. The safety belt should have elastic band or a section of an inner tube, 3 or 4 in. long, slipped over the half which carries the buckle. When the belt has been fastened, this band should be snapped over the end of the buckle, so that accidental release is unlikely. Several accidents have occurred as a result of pilots inadvertently loosening the buckle by catching it with their clothing. Take your time getting the belt adjusted. You can't do very accurate inverted flight if you are dangling in space. Check the seat adjustment to make sure it is locked. It is most disconcerting to roll over and suddenly find yourself head and shoulders out of the cockpit, even if you know you're not going any further and there is an instructor on hand to right the ship. If you are alone, such a mishap might be serious. Incidentally, when you go solo, check and double check to see that the belt in the empty cockpit is *tied* down snugly, (not merely buckled) and that all loose cushions or other objects are removed.

Having tightened the belt to your satisfaction, move all controls through their full throw, just to see that you can reach them. In some maneuvers you'll need the last quarter-inch; make sure you can get it. If not, you may have to add or remove a back cushion, or make some other adjustment. If you use a cushion, see that it cannot fall out when the ship is inverted.

All set? Okay. Start the engine, see that the tail wheel is unlocked, release the parking brakes and taxi to the take-off position. Lock the brakes, "rev up" the engine, check the mags and instruments, lock the tail wheel, make sure the field is clear and no one is landing, take off and climb to 2,500 ft. and get ready for our first maneuver which is

The author has been flying since 1917 as test pilot, commercial operator, and flight instructor. He has written numerous books and articles on various branches of aviation and is co-author of CAA Bulletin No. 23, "Civil Training Manual" and Bulletin No. 5, "Flight Instructor's Manual." Needless to say, he has a Commercial Pilot's Certificate (No. 354) with Preliminary and Secondary Instructor ratings.

The Chandelle

The simple type of chandelle is merely a steep climbing turn, usually preceded by a slight power dive to pick up speed. We are not particularly interested in this type, since you have had climbing turns and little of new value is found in making them steeper. The so-called "advanced" type, however, is another proposition. To perform it perfectly calls for excellent "feel" of the ship, delicate use of the controls, and all-round good piloting. When so performed it is a beautiful maneuver, and one that will give you lots of satisfaction.

The maneuver, which is illustrated in Fig. 1, is practically an Immelman, executed in an oblique or diagonal, rather than a vertical plane. It is done as follows: select a straight stretch of road, preferably directly cross wind, so that the turn may be made into the wind. (The wind makes no difference in the maneuver. It simply serves to keep the student wind-conscious.) Fly along the road, and dive the ship slightly, until you have attained a speed a little above the top speed in level flight. As the speed increases, ease the

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The Cost of OWNING AND OPERATING Small Aircraft

How much does it cost to operate an airplane? Here is an interesting answer.

By Cyrl W. Terry

Ass't. Professor of Aeronautical Engineering

and

Paul Kellogg

Ass't. Prof. of Ornithology
Cornell University

THE recent stimulus given to aviation by the government subsidy, in the form of Civilian Pilot Training courses, has caused many individuals to consider the cost of flying. Pilots trained under the new program are faced with the problem of continuing their flying, and they must continue it if they are to keep their coveted ratings.

This study started with an attempt to determine the cost at which well-trained pilots might reasonably expect to buy flying time. The lack of ready information, however, made the search much more involved than was at first anticipated, and the final result is the data presented herewith.

The writers believe that the information presented will answer many of the questions frequently asked about the cost of flying. It should be helpful to individuals or groups considering the formation of flying clubs; and, finally, it should offer to operators of flying services a simple method of evaluating the cost of their service to the public in the light of presentday facts concerning aircraft.

The data were secured by many visits to air fields and factories, conferences with pilots, private owners, flying service operators, and with engineers. In particular, the writers wish to acknowledge the assistance of the engineering and executive staff of the Air-Cooled Motors Corp. of Syracuse, New York, Mr. H. M. Peters, and Mr. G. B. Hilton, of the Ithaca Flying Service, and Mr. M. J. Strock, of the Piper Aircraft Corp., for helpful discussions and material; and frequent reference was made to Professor K. D. Woods' book on Airplane Design.

The many factors involved in owning and operating a small airplane preclude any possibility of analyzing costs for every possible condition, but the various items are presented in such a form that the costs pertaining to any particular condition may be determined readily and with reasonable accuracy.

As a means of *short-distance* transportation, the airplane, in its present form, cannot compete with the automobile. Therefore, it must be considered as a vehicle for longer trips and for recreation and observation. The cost of private plane operation is still above that of the automobile. However, if a person were to spend as many hours traveling by plane as he does by car he would cover more than twice the distance, and the cost per mile by plane would, in many cases, be less.

Let us look at the costs of private flying. They fall conveniently into three groups: 1. Overhead, annual or fixed costs; 2. Running or hourly operating costs; 3. Airport costs. This last item is really one of the fixed costs, but, because in private flying it is usually paid for as hangar rent, or along with the price of gasoline, we propose to consider it separately.

The overhead or fixed costs are made up of items which are necessary in order to have the plane in condition to fly, and ordinarily they do not increase or decrease materially with the use of the plane. We shall consider four items as making up these costs: 1. Depreciation of the plane; 2. Interest on the investment; 3. Insurance; 4. Hangar rent.

This group of items is often considered as yearly costs and ordinarily must be incurred before the plane is ready to fly.

Running or hourly operating costs vary directly with the use of the plane. It is usual to compute these on the basis of a single hour of operation. We shall consider five items: gasoline, oil, engine and propeller upkeep, plane upkeep, minor accidents not covered by insurance.

We will now consider in more detail the various items mentioned above.

Overhead Costs

1. *Depreciation of the plane.* This is similar to that experienced in automobiles. However, the increasing market for planes has so far prevented any crystallization of the rate of depreciation. New planes suffer heavily the first year, as do new cars, but it is not uncommon for a plane to suffer much less, if any, depreciation for the second or third year. This effect is a function of demand and may change at any time, but the necessity for keeping planes airworthy should perhaps be given some credit for keeping the true value of the plane high. Fig. 1 perhaps gives a rather pessimistic view of the depreciation in a plane's resale value, but the writers feel that it is a fair picture of conditions for the past few years.

2. *Interest on the investment.* This item is often not considered, but it must be remembered that if money is borrowed with which to buy a plane, the borrower will normally have to pay interest at the rate of 6 percent. If one already possesses the money, it could be otherwise invested so as to bring a return.

★

What are your operating costs? If they differ from those suggested by the authors we would like to hear from you. We are especially interested in knowing the cost to members of flying clubs. Address your replies to the Editor.

3. *Insurance.* A number of conditions influence the kinds of insurance which should be carried. It is common for most owners to consider first, and, generally carry, some form of insurance covering damage to their airplane. Actually, however, a claim for personal injuries or for damage to the property of others can create a much greater loss. Where claims become the subject of litigation, expensive legal talent is required to defend them and one of the important features of liability and property damage insurance is that the insurance company takes over the defense of such claims. In the case of an airplane used for pleasure and personal business, this risk can be insured against for annual premiums of $40 for injuries to persons outside the plane in amounts of $5,000 for any one person and $10,000 for any one accident and $40 for damage to the property of others up to $1,000. If passengers are carried, the owner's responsibility to them may be insured against for a premium of $50 for a limit of $5,000 if the ship seats one passenger, $75 if two passenger seats and $20 for each additional. These limits may be increased for a relatively small additional premium. For instance the amount of insurance for bodily injuries to other than passengers may be doubled for an additional premium of $10.

During the past year, underwriters have made available a single limit liability policy. This policy includes all of the defense provisions of the standard form but is limited to a contribution up to $5,000 in the aggregate for the settlement of claims arising out of any one accident for all three of the coverages previously referred to, that is, injuries to persons outside the airplane, passengers, and damage to the property of others. The annual premium on a two-place airplane used for pleasure and personal business is $70.60.

There are various forms of insurance against the damage to the aircraft. The most common are: All perils while not in flight—with the term "flight" being defined as the time commencing with the beginning of the take-off run, while in the air and until the landing run is completed; all perils—ground and air—with crash losses being subject to a deductible of 10 percent of the amount of insurance. There are also several plans designed primarily for light planes which cover on the ground and in the air subject, except

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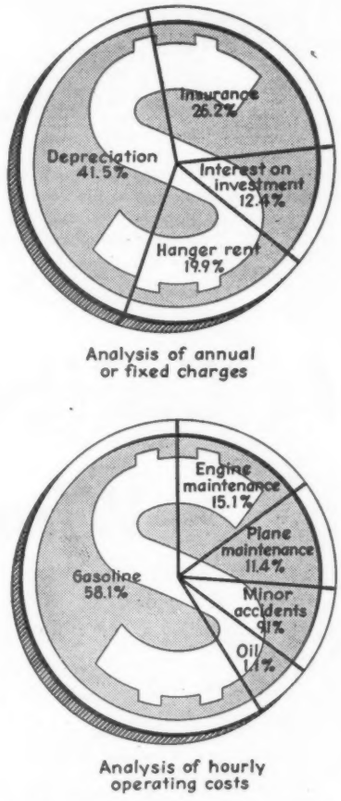


Fig. 2. Where the money goes

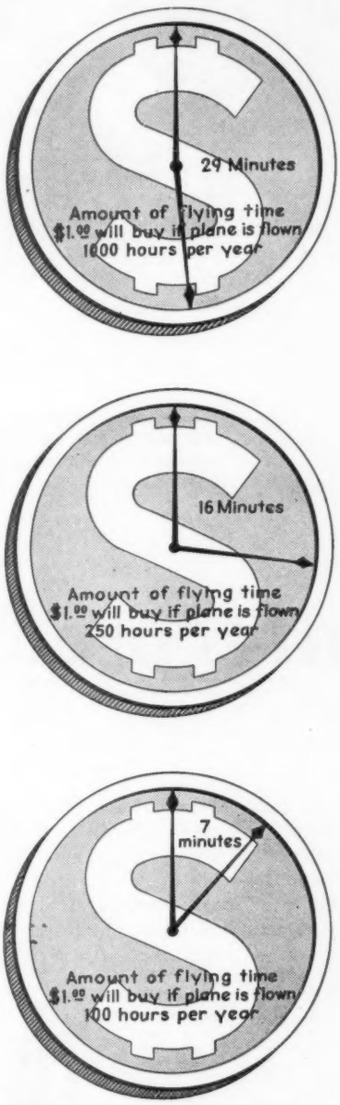


Fig. 4. The more you fly, the more you get for your flying dollar.

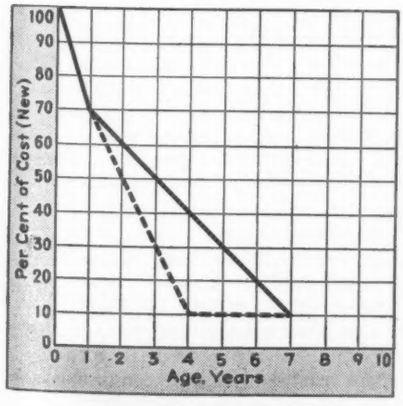


Fig. 1. Planes depreciate every year. Vertical scale shows percentage of cost, horizontal scale shows years. Broken line allows for 20 percent depreciation after first year; solid line shows 10 percent. Difference depends upon market, care and use.

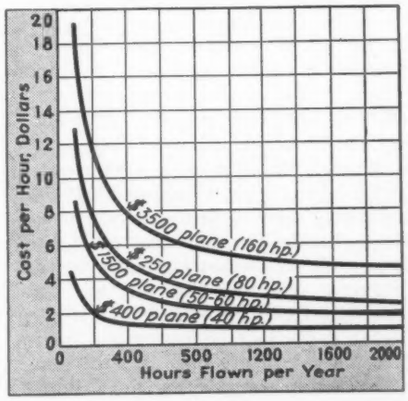


Fig. 3. How total cost per hour decreases as more hours are flown per year. Chart shows planes in four different price classes.

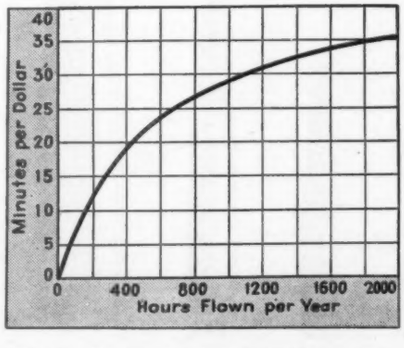
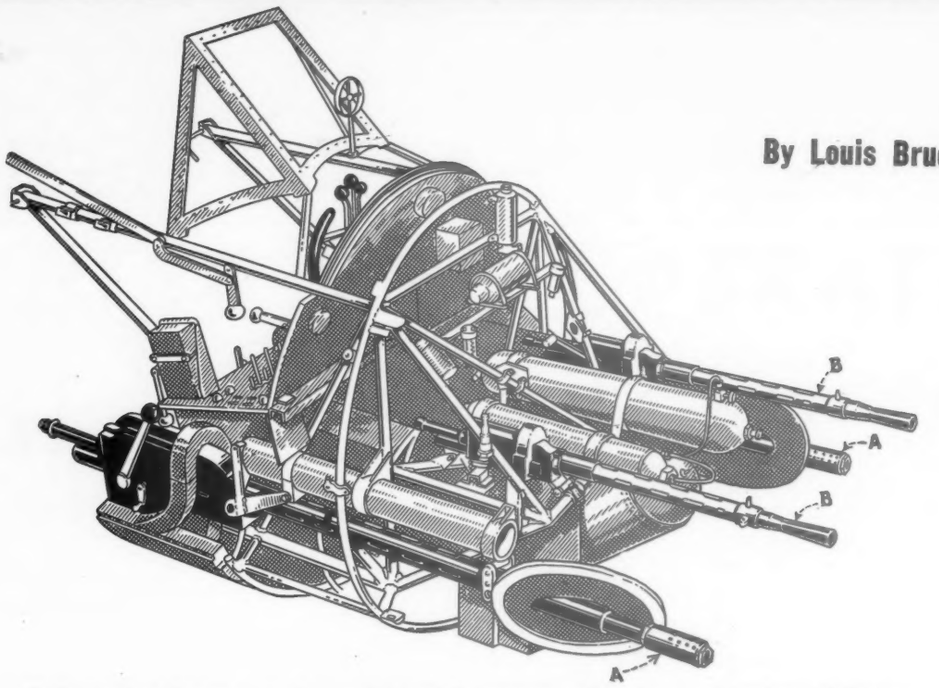


Fig. 5. Curve showing amount of time that may be had for one dollar as total number of hours flown per year increases.

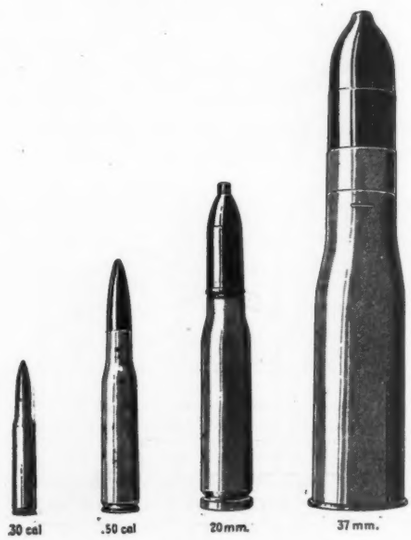
By Louis Bruchiss



Armament installation of the Fokker G.1. general purpose attack plane and bomber. With two 23 mm. cannon and two .30 cal. machine guns, mounted in the nose of this twin engined—two seat airplane, it represented an advanced design five years ago, and even today could hold its own. A. Two Madsen 23 mm. aircraft cannon. B. Two 7.9 Madsen machine guns.

Intermediate Caliber Aircraft —What Are They?

MORE than a year and a half of warfare in Europe has shown the world what was obvious many years ago: that those who have the most airplanes will achieve the most advantages. The United States has taken the lesson to heart with a vengeance. An aircraft production schedule based on a fleet of 50,000 airplanes is being worked out, and it is being revised continually to accommodate increases.



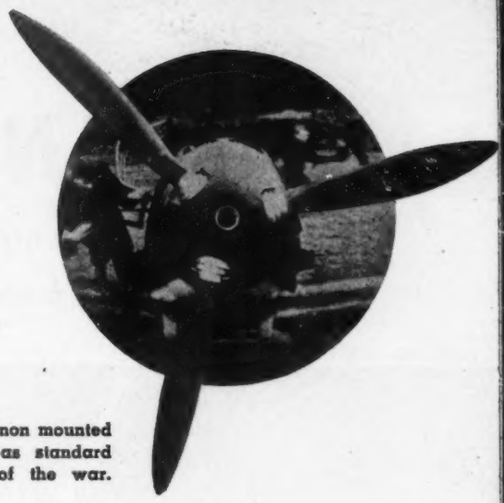
Comparative sizes of .30 cal., .50 cal., 20 mm., and 37 mm. ammunition.

The lack of sufficient military planes in our country has been recognized by many officials and private citizens as incompatible with our size, our position in international affairs, and our vital defense needs. But airplanes, particularly military airplanes, are worthless unless they are designed and built to carry out specific military purposes. As part of both defensive and offensive operations they must be equipped to carry and drop bombs of all calibers; they must be able to drive off or shoot down enemy aircraft; their own gunpower may be presumably used against enemy ground objects, besides the numerous other operations for which they can be employed.

Against opposing aircraft, an airplane, regardless of whether it is the lightest single-seat fighter or the heaviest bomber, can use only its own gunpower. As a prerequisite to the eventual effectiveness of that gunpower, the plane itself is important, of course, but planes are changing constantly insofar as the changes include speed, maneuverability, range of action and carrying capacity. All of these factors have an important influence on a plane's usefulness and have a direct connection to the armament or guns with which an airplane may be equipped.

Machine guns, both light and heavy, have been used for aircraft ever since the early days of the first World War until today. The only refinements we have today are novel and improved installations of the machine guns in the wings, fuselage, or landing gear of the airplane. Free or flexible guns for turret mounting located in various parts of the plane, such as the nose, tail, bottom or top have become more effective through multiple mounting of the guns up to the number of four, in motorized or power driven turrets, thereby taking the strain from the gunner, of swinging heavy guns around on a Scarff type ring. But the machine gun has been gradually losing favor, because, with increasing speeds of military planes, the percentage of hits scored as against errors decreases in proportion to the speed of the plane, whereas at best, machine gun bullets would not always be effective, even if they did hit. Modern planes are largely

Nearly every type of warplane now used by the belligerent powers carries a small or medium caliber cannon. In this article the author describes the part played by machine guns and the various sizes of aircraft cannon in combat airplanes



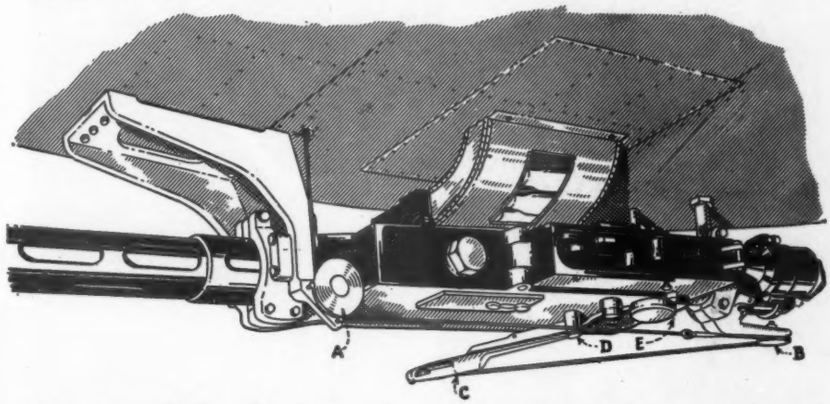
The Messerschmitt Me 109 had a cannon mounted in the nose through the propeller, as standard equipment, at the very beginning of the war.

Cannon

made of metal and can sometimes sustain hundreds of hits from machine gun bullets without being put out of action. Of course, there are always vital parts, such as the gas tank, certain sections of the engine and controls, and the pilot himself. But gas tanks are now made self-sealing after being punctured, by having rubber inner tanks and other devices attached. So unless the pilot is hit, a machine gun must score heavily against a plane to bring it down or put it out of action.

Practically every type of warplane now used by the belligerent powers therefore carries small or intermediate caliber automatic cannon firing explosive shells weighing around ½ to 1 lb. A hit by one of these shells will almost surely damage a plane to such an extent that it will either be brought down immediately or consider itself lucky if it can sneak back to its base, badly crippled. The shells from these automatic cannon explode on contact, but they are also equipped with time fuses which cause self-explosion after about 10 sec. so that they will not inflict damage to civilians and friendly ground objects in case they miss their target.

A typical outboard or underslung wing mounting of a Madsen aircraft cannon. A to E, charging handle control cable, pulleys and lever arms. At extreme right is the solenoid for trigger device.



The fire power or firing rate of the various intermediate caliber automatic cannon compares very favorably with that of machine guns and much more so than the heaviest aircraft cannon used. But even the high firing rates of aircraft machine guns, up to 1,500 rounds per min., probably give a false impression to the layman. With the apparent stream of fire available from a machine gun, it would appear that aircraft targets must surely always be hit. Nothing is further from the truth. The actual chances of scoring hits from plane to plane are ridiculously low, and this is due to the fact that a plane has a three-dimensional sphere of action. When firing from another plane, which is also in movement and therefore provides an unstable base, the gunner is lucky if he can score more than a few hits with a machine gun. Assume, for example a speed of 360 miles an hour for a plane. If we reduce this to 6 miles per min., we have 1 mile in 10 sec. or 528 ft. per sec. On the other hand, with the average light machine gun firing say, 1,200 rounds per min., of which one-fifth would be tracers

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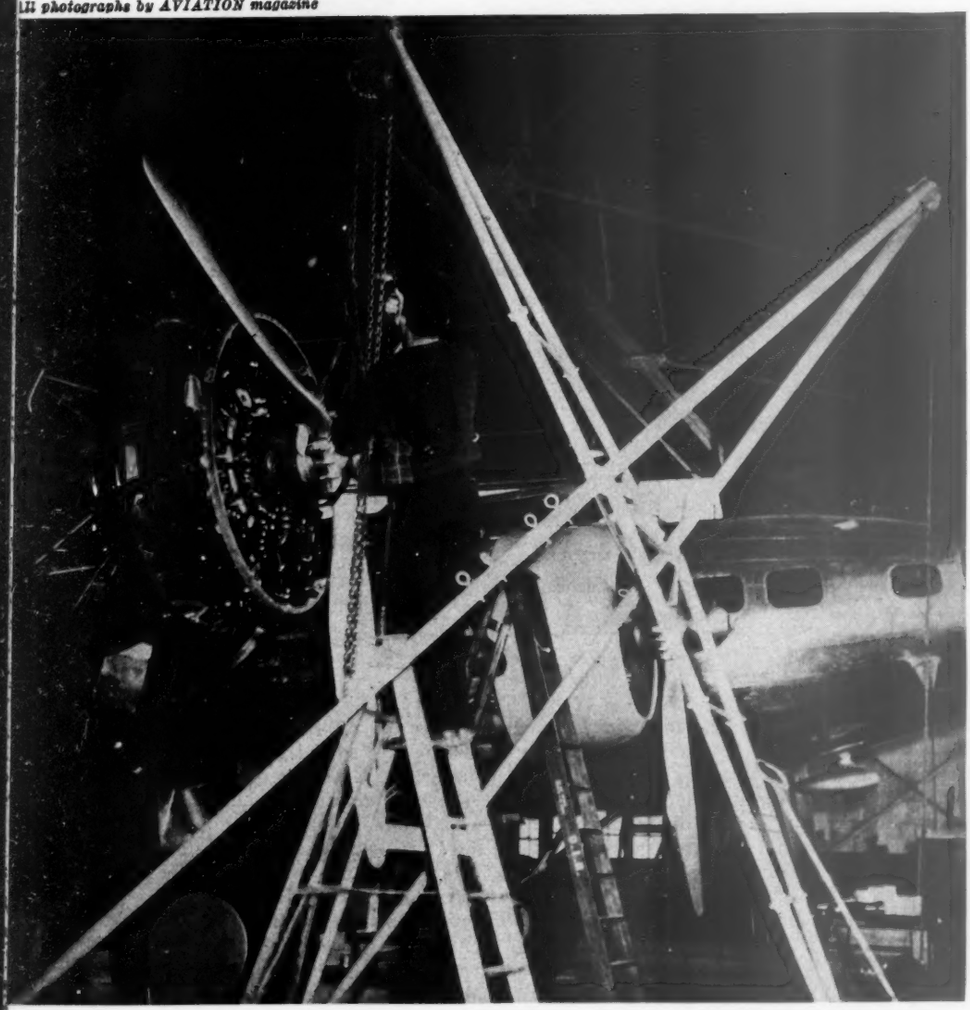
COMPARATIVE TABLE OF CHARACTERISTICS OF AIRCRAFT MACHINE GUNS AND AIRCRAFT CANNON

Specifications:	1 Aircraft Machine Gun, caliber .30 (7.6 mm.) (American Browning)	2 Aircraft Machine Gun, caliber .50 (12.7 mm.) (American Browning)	3 Aircraft Cannon (20 mm.) (Madsen)	4 Aircraft Cannon (23 mm.) (Madsen)	5 Aircraft Cannon (37 mm.) (Turret) (American Armament Corp.)
1. Weight of gun in pounds	24.1	52	118.8	118.8	135
2. Overall length of gun in inches	40.2	54	78.4	78.4	35
3. Length of barrel in inches	24	36	47	47	29.14
4. Rate of automatic fire, rounds per minute	1000-1250	400-650	350 drum 500 belt	400	125
5. Muzzle velocity, feet per second	2,660	2,550	2,920	2,395	1,250
6. Type of operation	recoil, full automatic	recoil, full automatic	recoil, full automatic	recoil, full automatic	recoil, full automatic
7. Type of cartridge or shell feeding	disintegrating belt	disintegrating belt	disintegrating belt	disintegrating belt	fixed clip 5 rounds
8. Length of recoil, in inches	4.4	.....	3.9	3.9	10
9. Type of ammunition	Armor piercing tracer	Armor piercing tracer	Explosive shell, Tracer incendiary	Explosive shell, Tracer incendiary	Explosive shell, Tracer incendiary
10. Weight of complete round of ammunition	395 grains	1,825 grains	10.5 oz.	11.9 oz.	1.4 lb.
11. Weight of bullet or shell only	.....	743 grains	4.64 oz.	6 oz.	1.1 lb.
12. Force of recoil, single shot firing, in pounds	.....	.....	440	330	1,000
13. Force of recoil, automatic firing, in pounds	.....	.....	484	396	1,000
14. Twist of groove in barrel (rifling) in calibers	.....	.....	36	36	25
15. Weight of ammunition with belt or clip in pounds	100 rounds=6.6	100 rounds=30	100 rounds=76.6	100 rounds=82.5	100 rounds=164 5 round clip=8.2
16. Maximum effective practical range, in yards	200	300	1,200	1,000	300
17. Maximum effective theoretical range, in yards	600	900	2,400	2,000	600

SAN ANTONIO AIR DEPOT

With rapid Air Corps expansion a new and greater responsibility is being placed on its airplane and engine overhaul bases

All photographs by AVIATION magazine



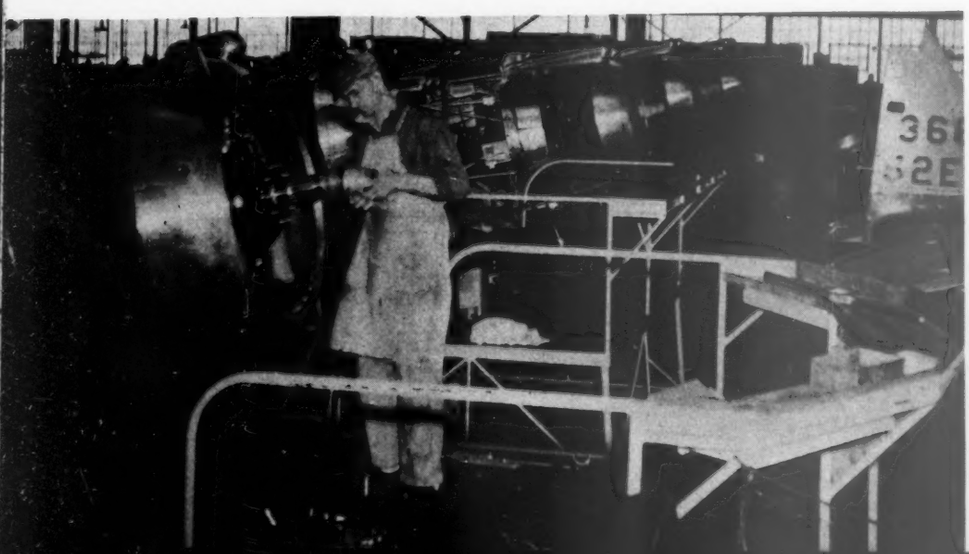
AN air corps is only as good as its maintenance system. If fighting planes are to accomplish their missions, if engines are to purr smoothly on difficult flights, the maintenance organization on the ground must be efficient and trained to a state of perfection.

In the system of maintenance used by our Air Corps, great reliance is placed upon the four depots located at Harrisburg, Dayton, Sacramento and San Antonio. These are the major overhaul stations where engines, propellers, accessories and even the planes themselves are sent for complete overhaul. Daily and monthly checks are made at the flying fields, but only the depots are equipped to do such complex jobs as tearing down and rebuilding engines or making major structural repairs in large bombers.

Largest of U. S. depots is at Duncan Field, San Antonio. Its 1,900 trained

Depot maintenance experts tackle anything, from Flying Fortress above to Link Trainers at the right. Below: a line of Republic pursuits originally built for Sweden being modified slightly for use as advanced trainers. Ships arrived at Duncan as boxed for export.

Link Trainers from Randolph, Kelley and other training fields are sent here for periodic overhaul.



Below: Aluminum alloy panels being built to replace fabric panels for the sides of some 350 BT-9 and BC-1 planes.

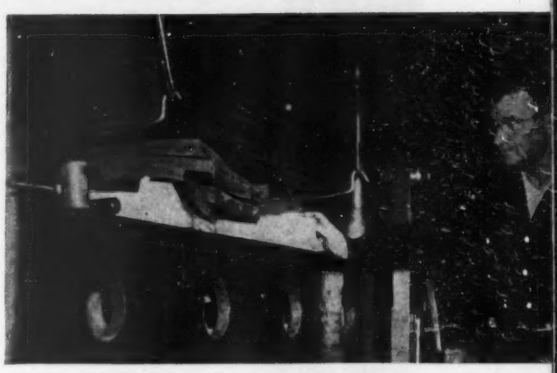
mechanics are the guardians of equipment for some 1,000 airplanes. In the course of a month as many as 250 engines, 2,000 instruments, 15,000 spark plugs, 350 starters and hundreds of other items will flow through the depot for complete disassembly, rebuilding and testing. Then they are sent back to the tactical squadrons or training centers for installation.

In addition to this overhaul and rebuilding of removable parts of the airplane, a vast amount of fabrication work is done at Duncan. A visitor to the depot, catching a glimpse of a line of Republic ships, as shown on the opposite page, may conclude he is in an airplane factory. The sheetmetal shop with its hydraulic press, forming equipment and the busy rat-tat of rivet guns, and the huge machine shop are especially reminiscent of manufacturing plants.

Work in the huge 6-acre building which houses the overhaul shops is under the direction of Col. Clements McMullen, Station Engineering Officer, and R. H. Van Horn, who is Shop Superintendent. While the commanding officer and his assistant engineers are Air Corps officers, the Shop Superintendent and the balance of the personnel are civilians who have qualified for their jobs through federal civil service examinations. Civilian employees have doubled in the past eight months due to the increased volume of work flowing through the depot. The engine overhaul shop is now operating on two shifts per day, and the machine shop and sheetmetal departments have so much work they are running on three shifts.

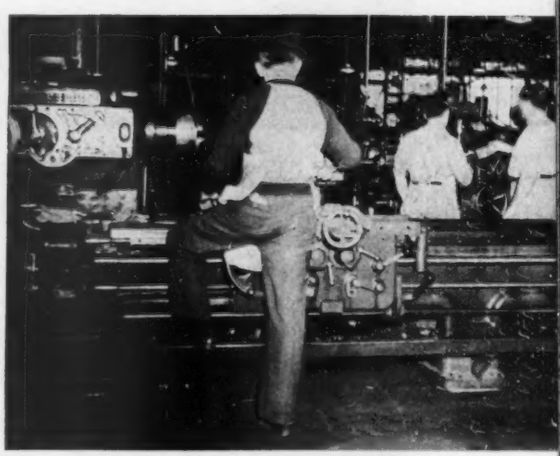
Work at any Air Corps depot is complicated because of the many different kinds of airplanes and engines being serviced. In a commercial airline shop there are seldom more than two kinds of engines to be overhauled. At Duncan Field in February there were more than 15 different types of engines sent through the shops. As the photographs indicate, everything from Link Trainers to Flying Fortresses may come in for repairs or alterations. Both the pilots and the mechanics at Air Corps flying fields have great confidence in the work of the depots—a confidence that over the years has been justified.

Right: An ingenious work stand built here. Wheel at top of ladder can be turned to elevate horizontal platform by means of worm gear and cables. The stand is also useful for working over wing surfaces.



Because of the amount of sheet metal work turned out, this hydraulic press is always busy.

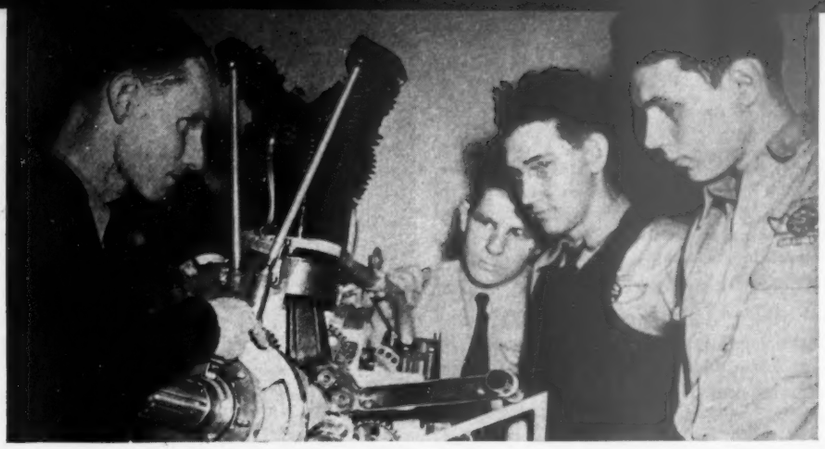
A section of the accessories shop. Equipment from about 1,000 airplanes is maintained here. Scores of specialists have been trained for this work.



This 36-in. Sidney lathe is one of scores of machine tools used daily in the large engine shop.

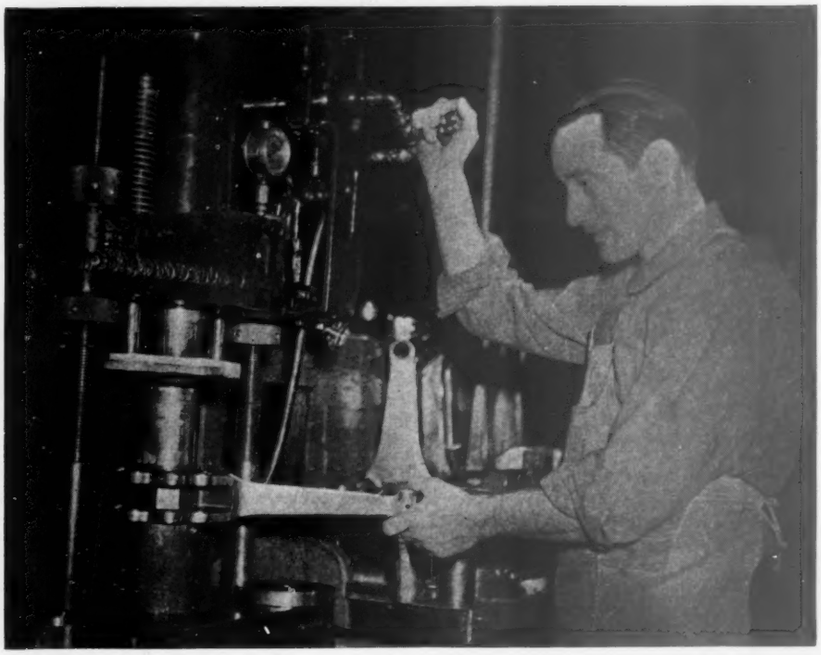
Below: This generator test bench is but a fraction of the Depot's test facilities.

Below: The largest instrument overhaul shop in America is at Duncan Field.

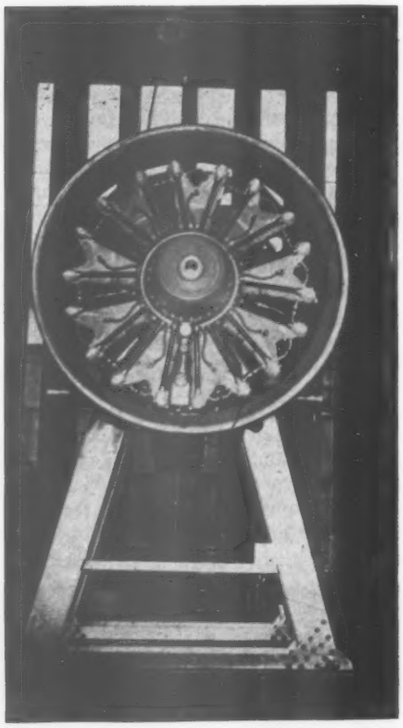


All photographs by AVIATION magazine

With the tremendous expansion in personnel that has taken place in recent months, the Depot has been forced to set up its own training system. About 100 NYA boys are learning trades, and nearly that many four-year apprentices are combining working with learning. This shows an instructor teaching engine operation with a cutaway model in one of the school classrooms.

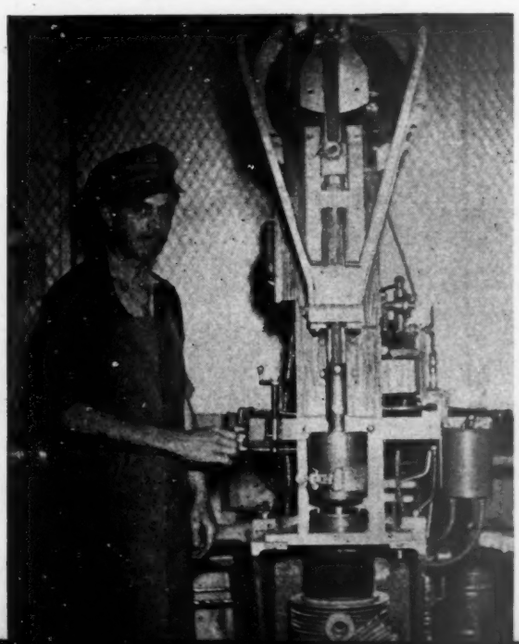


A 3,000-lb. air-power hydraulic press for forcing the bearing out of a master rod. An air motor drives oil into a cylinder which exerts pressure on the bearing. This is one of many machines designed and built here. Men in the engine shop have shown great ingenuity in speeding overhaul.



Duncan Field now has ten engine test cells and four more are being built to accommodate the steadily increasing volume of engines flowing through the shops.

A cylinder lapping machine designed and built here. Wood polishing block turns by hydraulic means, vertical drive is electric. This machine does 150 strokes per minute and has done its share to speed engine work.

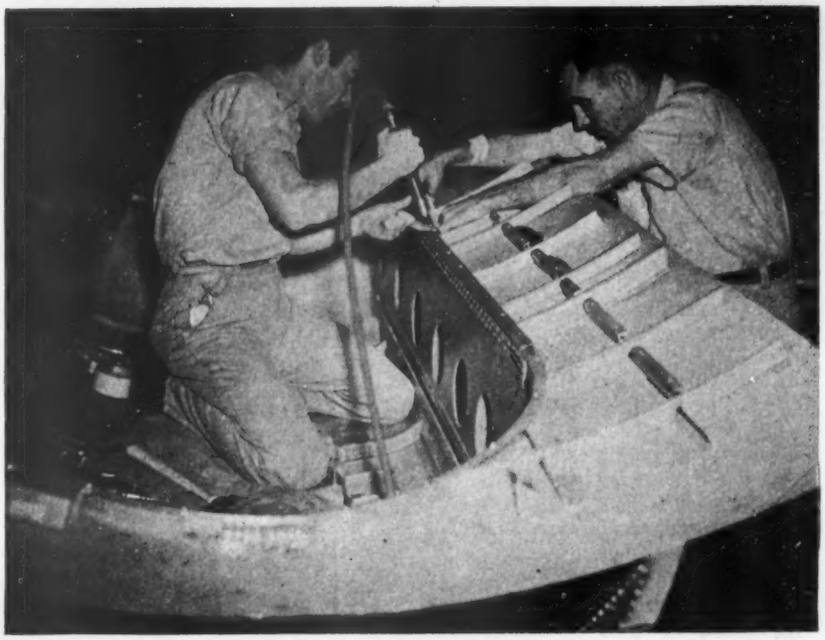


Assembly of the front and rear halves of a crankshaft. The hydraulic pump at right exerts a pressure from 800 to 1,000 lb. The pump can be secured in place in a few minutes and is so effective that it saves from 15 to 30 min. in the assembly of each radial engine. Duncan Field design.

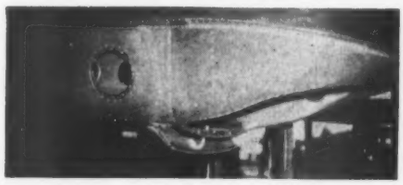
Bathtubs for the B-17's

Duncan Field is more than a maintenance base—it is a small aircraft factory. It has the skilled workmen and equipment to build or rebuild almost any kind of airplane. The early versions of the famous Boeing B-17 are now four years old. To bring them up to the perfection of the B-17-D series now coming off the Boeing assembly lines, mechanics at this base are making a number of changes, some of which are shown here.

The blister on the fuselage roof is being removed and a new cover is being streamlined into the forward section. Side blisters are coming off to be replaced by flush windows. Greatest change is the addition of the bathtub, shown in these photographs.

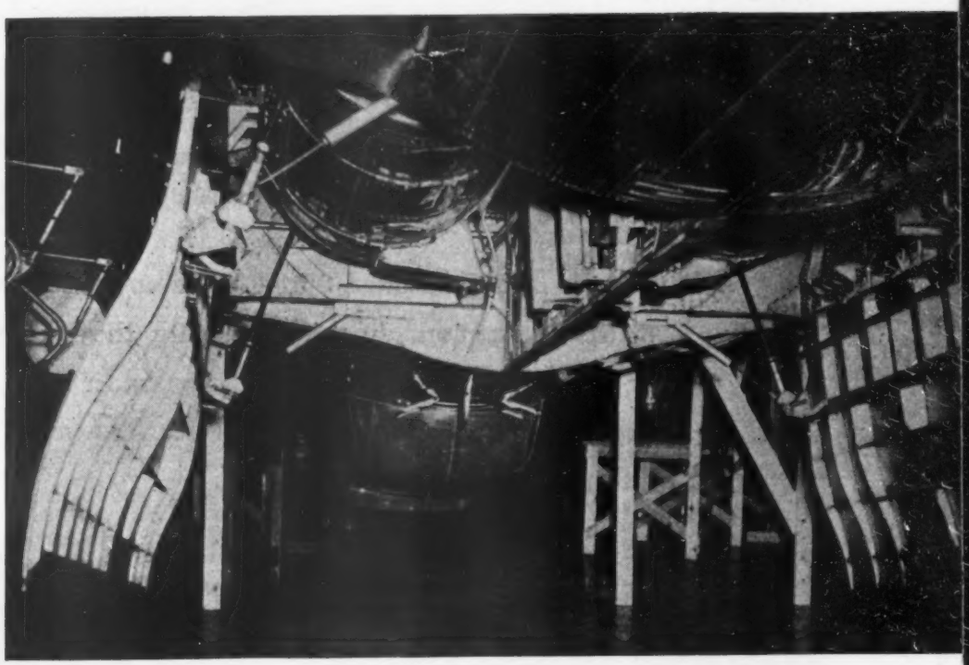


Why the mechanics call them bathtubs. Designs and prints were worked out cooperatively between Wright Field and the Boeing factory. All work on the building and installation of this equipment is done at the depot.



A close-up view of the bathtub after installation on the ship's belly.

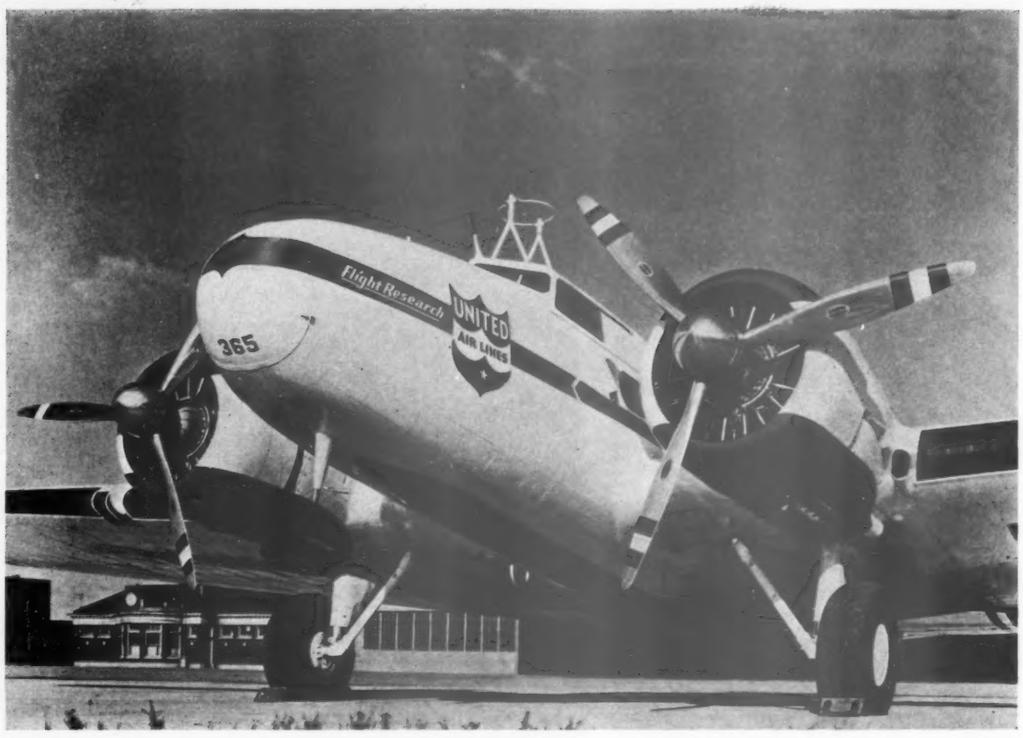
Old-style blisters being removed from the sides of the Flying Fortresses.



A view of a B-17 taken from beneath the nose and looking toward the tail. Bomb bay doors are open, showing emergency gasoline tanks temporarily installed. In the rear center is seen the bathtub which has just been added.

New-style, flush type openings that replace the protruding blisters.

Above: This plastic opening on the roof of the Boeings is being removed from all B-17's. It is being replaced with the smoother and larger Plexiglas cover shown at the right, which is streamlined into the pilot's compartment forward.



The United Air Lines Flight Research plane, the only one of its kind in the world, has been used to great advantage in the development of the new equipment.

GROUND STATION DIRECTION

Europe and the United States have employed two different systems of air navigation. In the possibility that navigation by triangulation will be used in this country as in Europe, United Air Lines has been studying equipment for the most efficient operation.

By Peter C. Sandretto

Superintendent Radio Communications Laboratory, United Air Lines

WHEN commercial flying began in Europe, large cabin planes were placed in service and the Europeans decided on a radio navigational system which closely followed the system which had been used on shipboard. Each plane had installed on it a long-wave transmitter and carried a radio operator. Whenever the captain of the plane wanted to know his position he wrote a message on a piece of paper and passed it to the radio operator. The radio operator in turn requested a bearing report from the ground stations. The ground stations using conventional direction finders took bearings on the plane and advised the radio operator (by radio telegraphy) of the plane's position.

P. C. Sandretto

In this country, however, commercial aviation was begun by flying the mail in single motored planes employing a single pilot. The European method was obviously too cumbersome and unworkable when the plane had only one crew member so the present radio range system operating on low frequencies was evolved. In order to have transmission over long range without the use of a trailing wire antenna (eliminating the necessity for the pilot manipulating a hand reel) the plane's radio transmitter was telephonic and made use of the medium - high - Ionosphere - propagated-frequencies. As commercial aviation develcped in the United States it became apparent that it would be very desirable if the position of the plane could also be checked by the dispatcher on the ground. There is one case on record where a pilot, in order to avoid a storm flew higher and higher until he reached an altitude where his thinking processes were so handicapped that he was no longer able to navigate the plane and he was saved only because of instructions issued to him by the ground crew. Of course, oxygen is

supplied to all pilots and the above incident would not occur for the same reason now, but it is consistent with modern trend of responsibility by ground personnel, to provide a means whereby the plane's position may be known from the ground and the plane in a measure navigated by a ground crew, if necessary.

However, as has previously been stated, the plane's transmitter utilizes Ionosphere propagated waves and no successful direction finder has been available. This statement may be a surprise to some who have been reading the magazine articles and noting the statements made by various companies, month after month, announcing dozens of different kinds of radio direction finders ranging from simple manual operated units to the complex automatic direction finders which, as their name indicates, give bearings whenever the station is tuned in. The reason that plane direction finders are so common and ground direction finders are so rare lies in the waves that are used. The aircraft direction finders rely for their bearings on the long-wave stations in the beacon (or even broadcast range) but the ground direction finders must rely on the radio transmitters which operate on waves behaving far different than the long waves. Light waves are electromagnetic waves and since electromagnetic waves are radio waves we can easily demonstrate the difference between long and short waves by turning on a desk light. Suppose you are seated across the room from a desk light and are asked where the light comes from. You can readily point to the source of light with your finger because the light comes to you directly. Long-waves behave in this manner. They come *directly* to the receiving station and consequently finding the direction from which they come is very simple. Short waves, however, are absorbed by the ground soon after they leave the transmitter. The direct ray from the transmitter is generally lost completely after it has traveled about 30 miles. We can demonstrate this by putting a screen in front of the desk light just a short distance from it. How then do we hear short wave transmissions over such long distances? We hear these stations because of a reflecting layer located some 60 miles above the earth and called the Ionosphere. We can demonstrate this layer in a light experiment by attaching a mirror to the ceiling of the room above the desk light, but in such a position that we can see the reflection of the light in the mirror from where we are sitting. It is instantly apparent now that assuming we do not know where the light is located (someone has moved it back of the screen) we have difficulty in telling of its location by looking at the mirror. The problem, however, would not be too difficult if the Ionosphere were a fixed surface similar to the mirror, but actually it is made of ionized gas which moves about like the surface of the ocean. We can demonstrate this by suspending the mirror with rubber bands and attaching a string to it which the office boy jerks about. We can readily see that your chances of telling the location of the light are now very few. This is exactly the problem of direction finding on the radio waves emitted by commercial United States planes.

United Air Lines began a study of this problem more than four years ago. After a study of current literature it was found possible to construct direction finders which had workable accuracies most of the time but occasionally produced extreme inaccuracies (errors as large as 90 deg.). It was decided that the most practical system was one which rather than giving highly accurate bearings would never give high inaccurate bearings. Many systems were tried. One of these used a large Adcock array which rotated to the bearing of the station while an averager averaged the bearings from the oscillating layer. While the accuracy from this device seemed excellent under certain conditions it was not

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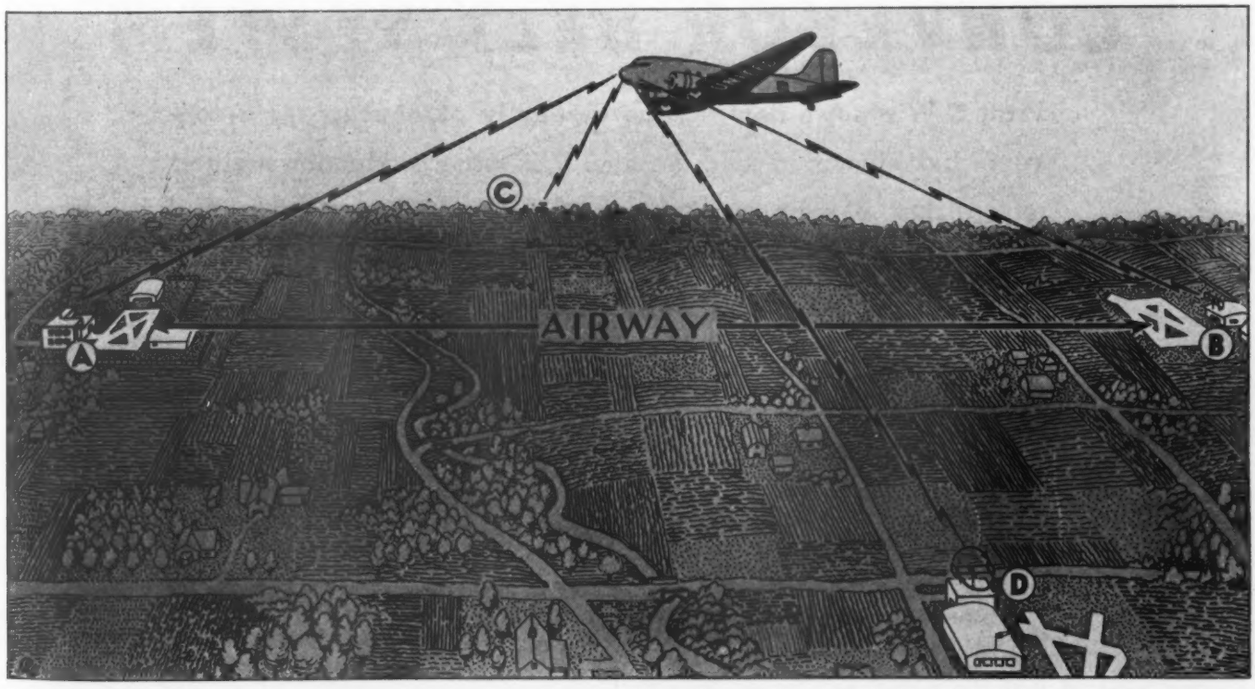
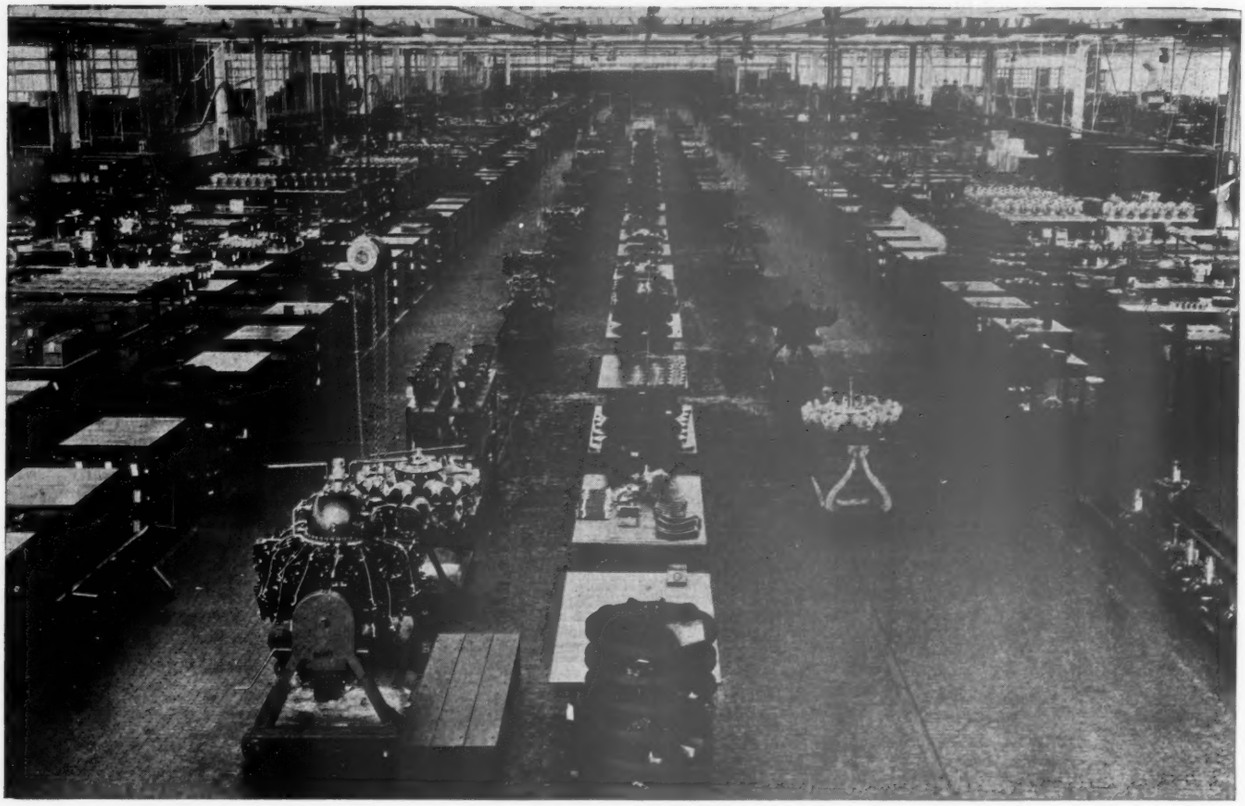
FINDER



By taking simultaneous bearings, stations "A" or "B", directly on the airway, can work with stations "C" or "D", off the airway, in triangulating and determining the planes exact position for the pilot.



Looking back from the final end of the green assembly lines. Just left of the center is the twin row green assembly line and on the right the single row. At the left side of the picture can be seen the two tracks of the conveyor belt; one for traveling down past the main floor storage bins and the one nearer the assembly lines for traveling back and "up-current" to feed the twin row subassembly lines. When the belt reaches the far end of the plant it travels up overhead across the back and down the right side to feed the single row subassembly lines which feed in herringbone fashion to the green line.

CONVEYOR BELT SYSTEM

Pratt & Whitney's new engine assembly plant employs a conveyor belt system to feed the line. This mass production method is reflected in their production rate of 1,000,000 hp. per month and a daily increase of ten per cent in airplane engine production

ENGINE PRODUCTION reached a new level of more than 1,000,000 hp. per month at Pratt & Whitney Aircraft when the new assembly building was opened recently at the East Hartford Plant. For the first time a conveyor belt was installed as an integral part of the assembly line and serves as a fundamental unit in the line production process now operating in the plant.

This conveyor belt system is a method of supplying the assembly lines with the necessary finished parts, and to do this travels a rather intricate course back and forth throughout the length of the building.

Known as Plant "F" the new addition includes more than 330,000 sq.ft. of manufacturing floor space entirely devoted to engine assembly operations. The addition of this to Pratt & Whitney's already greatly expanded plant brings the total floor space to approximately 1,600,000 sq.ft., and is the last of four new factory buildings which have bene completed within less than two years. Incidentally the "F" is the same size as the entire P&W plant was two years ago. It was built specifically to increase engine output for the Army and Navy under the National Defense Program.

The conveyor belt system was designed with the idea of supplying the assembly lines with parts for 400 engines in various stages of completion, is almost a mile long and can carry a live load of 65,000 lb. at speeds of from 10 to 35 ft. per min. Power is supplied by two 3-hp. motors. At present Pratt & Whitney is producing in mass production four models starting with their Wasp Jr. at around 450 hp.; then the Wasp at around 600 hp.; the Twin Wasp Jr. around 850 hp.; the Twin Wasp at around 1,200 hp.; the Double Wasp at 1,850 to 2,000 hp.

During assembly, engines must first undergo "green" assembly which is the first assembly of the motor, and the conveyor belt was installed to supply

this line. When they come off the green assembly line the engines are taken by an overhead monorail system through a 900 ft. passageway into the test houses and put through their initial run-in. The new plant "F" assembly building has two 128-ft. bays and off this a two-story 64-ft. bay with a mezzanine containing storage racks and bins, which are on both this and the main floor. Next to this bay, and traveling lengthwise in the building, are the two green assembly lines; one for the Wasp Jr. and Wasp, single-row engines and another for the Twin Wasp and Double Wasp, twin-row engines. Then comes an aisle dividing the plant and on the other side are tear down and inspection benches, the final assembly lines, and the shipping department.

Conveyor Belt System

The end of this building has been attached to the end of the main plant so that it is located at the end of the production lines. It is at this end of the main building that the conveyor belt system begins. From the illustration the overhead installation with hanging pans can be seen. These pans are loaded with the finished parts in the main building, which is at the left end in the photograph, and to the pan is attached the correct storage bay number for that part. The conveyor belt then travels to and along the mezzanine floor of the storage bay. At the far end it passes down to the main floor and back along the downstairs storage bins. While doing this, the finished parts from the main plant are taken off and the correct number of finished parts to feed the assembly line are loaded on, together with a corresponding number for the right station on the assembly floor.

The production control department knows exactly how many parts should be sent to each department, and at what time, to keep an even flow of engines down the assembly line while not overcrowding any one station with excess parts. Thus when the conveyor belt has traveled down along the mezzanine and back past the main floor storage bins it has supplied the store rooms and has taken on from them supplies for the production line.

The belt then makes a hairpin turn and the pans are conveyed back along the subassembly line starting at the final end and moving up-current to the beginning. Perpendicular to this section of the belt run small subassembly lines which feed, in herringbone fashion, to the double-row green line. When the belt has reached the beginning of the line it swings up to the ceiling across the building and back down along the

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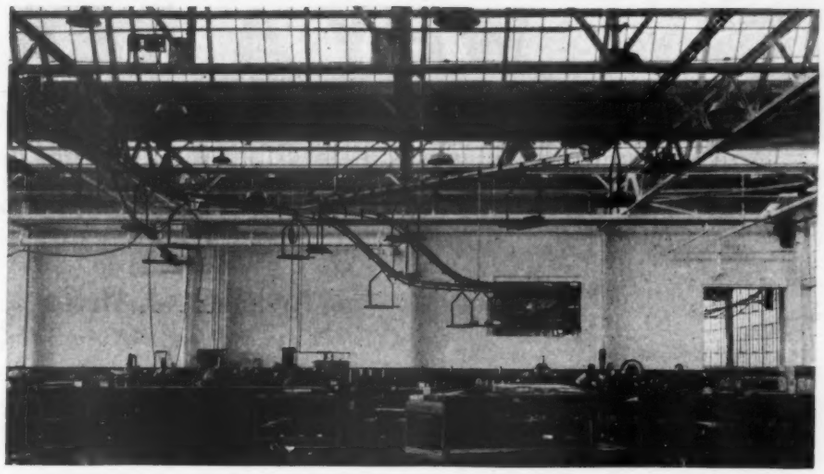
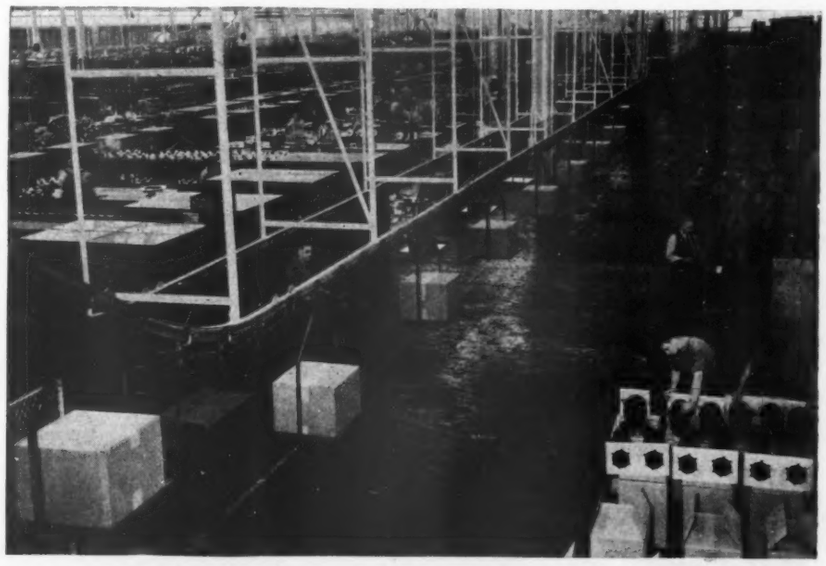


One end of the new plant is joined to the end of the production lines of the old plant. Through the hole in the wall the conveyor belt travels from these production lines into the assembly plant overhead and at the right top to the mezzanine stores.

Looking down the mezzanine stores showing the conveyor belt with hanging pans as they come in loaded from the production lines. Lighter finished parts are stored here, heavier parts are stored on the main floor below.



Coming down from the mezzanine stores at the left the conveyor belt travels along the main floor stores at the right making a hairpin turn at the far end and going back along the twin row subassembly lines at the left.

WHY A REAR ENGINE

Part II of this article describes the problems met and overcome in the extended drive shaft engine installation of the Bell P-39

By Robert J. Woods
Chief Design Engineer, Bell Aircraft Corp.

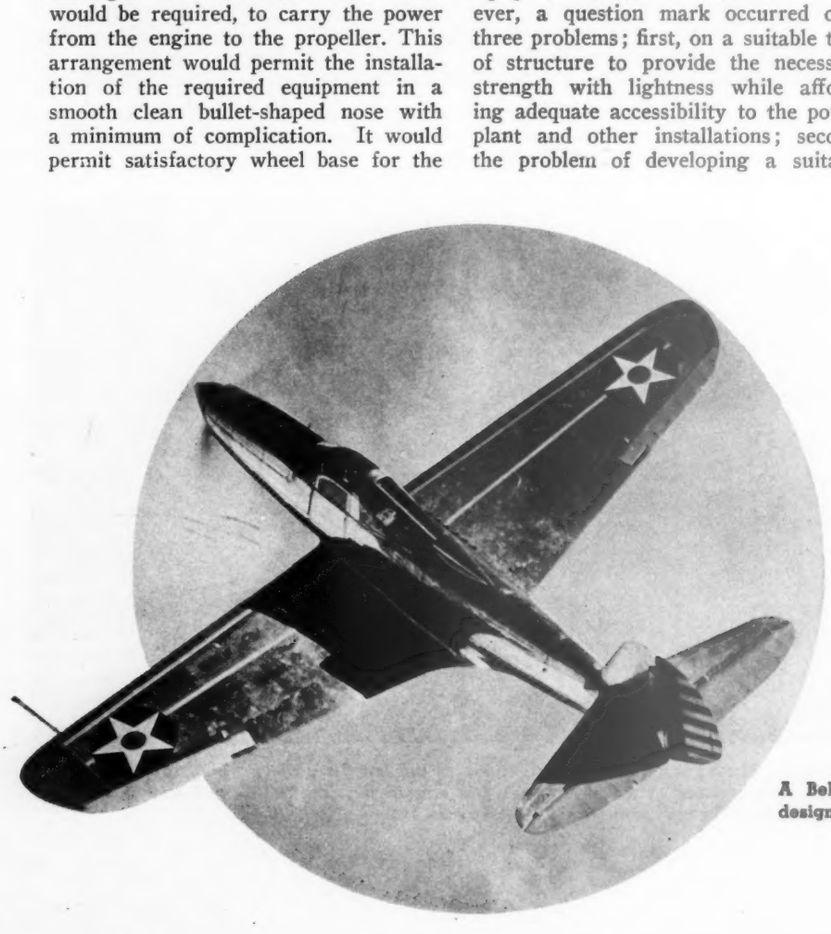
IN reviewing all the requirements (as set forth in Part I, AVIATION, March 1941 p. 36.) it appeared that a new solution to the problem of engine arrangement was essential for single-engined military airplanes if they were to provide all of the desired characteristics. It was obvious for even first considerations that some of the equipment ordinarily installed in the nose of the fuselage of the airplane must be relocated in some other place in the airplane. The propeller, the tricycle landing gear nose wheel and the guns were obviously required in the nose under any circumstances and it appeared that the biggest gain could be made by moving the engine from the usual position in the nose to a position amidships of the fuselage. An extension drive shaft would be required, to carry the power from the engine to the propeller. This arrangement would permit the installation of the required equipment in a smooth clean bullet-shaped nose with a minimum of complication. It would permit satisfactory wheel base for the tricycle gear and would permit development of a fuselage shape with optimum streamlining. If the engine were located aft of the pilot the design would permit also maximum vision for the pilot, especially forward and down in the critical areas used in military operations. It would provide an arrangement wherein the bulk of the engine and its installed equipment would not necessarily govern the design of the airplane structure. Such an arrangement has most desirable advantages and facilities for improved installation.

There were new problems to solve in making this change. Preliminary investigations and engineering layouts made to check the arrangement indicated that satisfactory balance and a good installation of all the required equipment could be obtained. However, a question mark occurred over three problems; first, on a suitable type of structure to provide the necessary strength with lightness while affording adequate accessibility to the power plant and other installations; second, the problem of developing a suitable extension drive shaft to conduct the engine power from the remotely located engine in the center of the fuselage to the propeller in the nose of the airplane, and last, but not least, solution of the problem of vibration resonances occurring in the aircraft structure from impulses generated by the engine, propeller or drive shaft. These problems were all really one, "how to develop a satisfactory extension drive shaft installation."

The airplane preliminary design indicated that a shaft approximately 120 in. long would be required to connect the engine and propeller. Since the airplane manufacturer was not equipped to furnish the engine and drive shaft equipment, a partnership type of development was necessary with the Allison Engineering Co., the engine manufacturer. Allison would build the engine and drive assembly and Bell Aircraft Corp. would furnish the supporting structure, with both the power plant and aircraft projects being coordinated through the Materiel Division of the Air Corps.

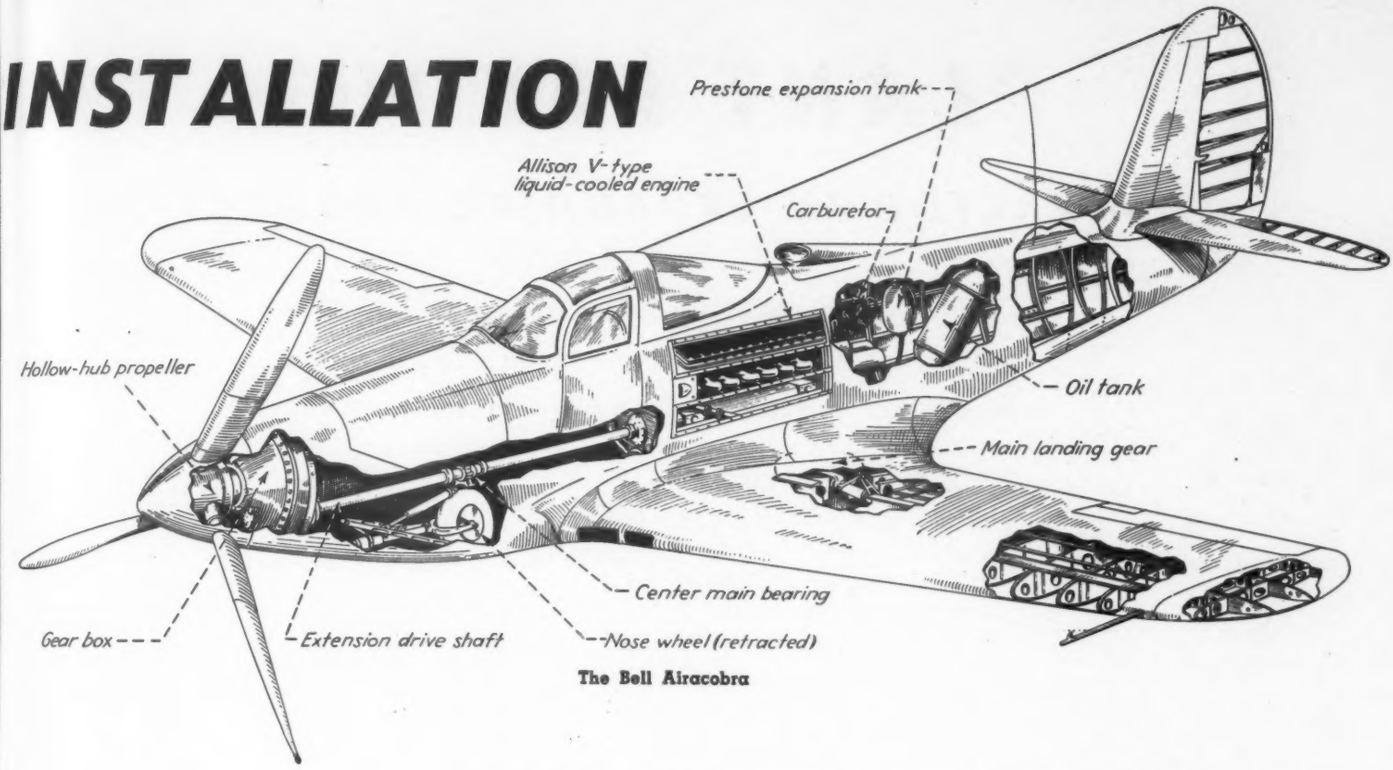
Careful work in the preliminary design stages on both the power plant and airplane was required to insure that the basic design conditions, which were critical, were properly determined and were maintained fixed once they were established. Without the whole-hearted support and cooperation of all parties concerned the job could not have been done.

Extension shafts are not new in that they have been previously used in numerous airplanes in England, Holland, Germany and in the United States, but extension shafts have never until now been adopted and used on production aircraft of any type. Their use has been confined principally to experimental types of airplanes. Information available indicated that reasonably satisfactory operation had been obtained from the extension shaft installations, but no really satisfactory



A Bell Airacobra in flight, showing the clean design of the nose.

INSTALLATION



The Bell Airacobra

arrangement had ever received general use, with one exception. The Bell Aircraft Corp. had had previous experience with an extension shaft arrangement on the Bell XFM-1 and YFM-1 Airacuda airplanes. In this instance the problem was to provide a 66 in. extension of the propeller shaft of an Allison engine to drive the pusher propellers used on that airplane. The set-up and development was comparatively simple in that a standard engine was used with an adaptor flange mounted on the regular engine propeller spline connected to a relatively stiff, large diameter extension shaft. Design and construction of this shaft and drive arrangement by the Allison Co. resulted in an installation which gave no major trouble of any kind during development and test and was the basis for the opinion that extension shaft installations were a satisfactory, practical mechanism that could be used on the new airplane without misgivings.

Comparing the experience and information available on other extension shaft installations without experience at Bell Aircraft on the shaft developed and furnished by Allison for use on the Airacuda, it became apparent two considerations were included by the Allison engineers in the solution of that extension propeller shaft problem that have not generally been considered in other designs. These were, first, extremely careful consideration of the torsional vibration characteristics of the engine and shaft system; second, careful detail design to permit angular flexibility in the drive and to eliminate eccentricities from occurring in the drive mechanism when angularity was present. It appeared that these two factors were the principal differences between the very successful Airacuda shaft installation and the generally satisfactory extension shafts used in other instances. On this basis it was believed that a satisfactory extension shaft turning at crank shaft speed, 120 in. long could be developed for the new P-39 airplane.

In conference with Allison and from a study of preliminary shaft designs worked out by Mr. R. M. Hazen, chief engineer of Allison, it was decided that satisfactory torsional vibration characteristics could be obtained and that if adequate flexibility could be provided in the drive shaft at each end and at the center and with concentric bearing supports at the flexible joints, a satisfactory extension drive shaft of extremely light weight and compact design could be produced. The reduction gear housing were to be removed from the engine and the shaft driven directly from the crank shaft at crank shaft speed. It was proposed that a reduction gear unit of 9:5 gear ratio would be located in the nose of the airplane provided with a hollow offset propeller shaft to permit the automatic shell firing aircraft cannon to be fired through the center of the propeller hub. Drives for the machine gun synchronizers and a propeller governor were to be provided for on the independent reduction gear box. The solution looked very good and the Allison Engineering Co. agreed to develop and furnish for installation in the new P-39 airplane a 1150 hp., type V-1710 Allison engine equipped with such an extension drive shaft arrangement. This power plant arrangement permitted a most compact and efficient installation and an ideal airplane arrangement.

The new airplane was laid out in-

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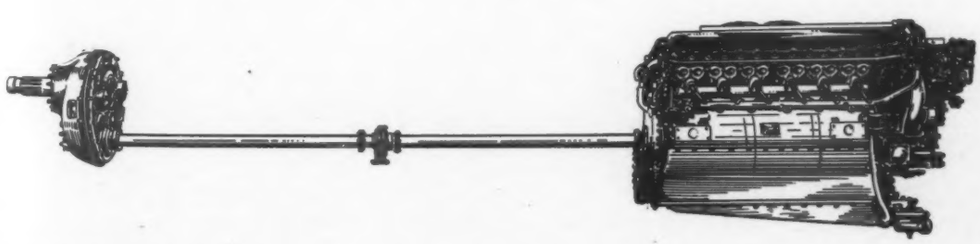


Many tough engineering problems had to be overcome in the design and development of the long drive shaft. This shows the Allison engine, the extension drive shaft, the center main bearing and the gear box.

PLANT LAYOUT

AS A FACTOR IN EXPANDING PRODUCTION

Layout of new plants is a common problem to the entire aeronautical industry. Here are ways to speed production through efficient physical arrangement.

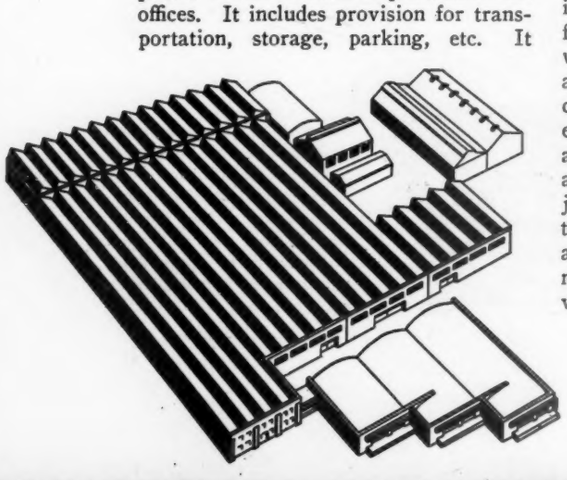
By C. W. S. Parsons *M.E., Consultant*

SINCE the beginning of the war the aircraft industry, for years a steadily growing river of human energy, has become like a rising flood, a raging torrent that has overflowed its banks, breaking over into the adjoining fields of many other industries, gathering into its hurrying tide a thousand tributary streams of active brains and skills.

But unlike a Mississippi, this rising flood of toiling men in the aircraft industry has had to be assimilated, organized. And not the least of the problems of assimilation has been to provide places to work and equipment with which to work. Each succeeding month has stepped up the picture of what plant and facilities must be provided to handle the increasing load. Each succeeding month has proved the earlier steps in expansion to be inadequate. Long before the end of 1940 the rate of growth was outstripping the mere enlargement of plants and factories. It had become also a matter of building whole new units.

But whether a parts shop or a factory is merely crowding in more machines and men, enlarging, or building new units, this business of providing places for men to work and equipment with which to work calls for an essential bit of engineering, i.e., plant layout.

Specifically, the layout of a plant or factory is the plan for the physical arrangement of all facilities and work places in the various departments and offices. It includes provision for transportation, storage, parking, etc. It takes into account all activity within the organization. As in the setting up of so many activities connected with industry, the creation of a layout requires the visualizing of the business operation as a whole, the coordination of advantages and needs connected with each separate function or department.

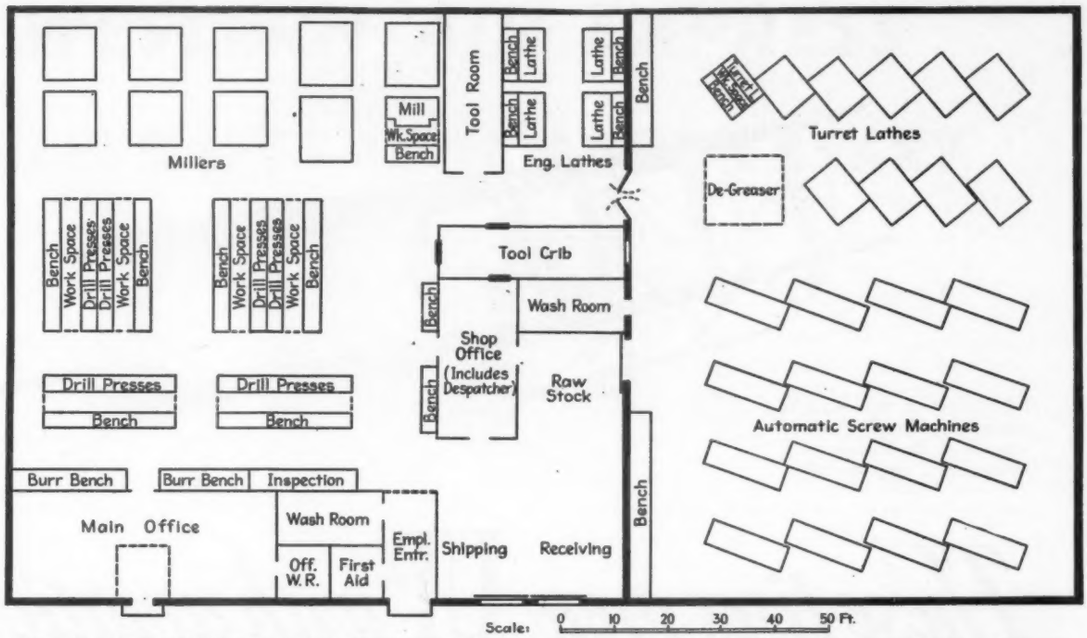


Obviously the working out of this principle involves making a series of decisions, some of which may be compromises. For instance, it is desirable to view the layout of operations as antecedent to the laying down of building lines. It is better to lay out the operations first and then determine the building to enclose them. But circumstances may require that the operations be housed in an existing building. Or the urgency for expansion may require that buildings and equipment be contracted for at once, the layout being completed while these contracts are under way. Hence plant layout calls for ingenuity, the provision for flexibility to meet unknown conditions and the exercise, if possible, of some degree of second sight.

Having determined upon what to make and how much, to the best of one's ability, the next thing to do is to break down the parts involved into assembly and fabrication operations, and to plot the load on a time schedule basis. The job shop can develop only a chart of its present load and from this and the information available from its aircraft factory customers decide how far it wants to go in expanding through the acquisition of more equipment to take care of a greater balanced load. The engineer undertaking layout work for a subcontracting manufacturer or an aircraft factory has a more detailed job on his hands. But the principle is the same. Even though the operations are more ramified and there are many more processes, it is necessary to develop a balanced man-hour or machine-hour load representing the work to be done.

In major layouts numerous factors must be borne in mind. For lack of time, lack of men to do the breakdown estimating, or for lack of accurate operation data, departmental hours on previous contracts may be considered all that are available. But using them directly means creating a layout of operations duplicating exactly or in multiple the facilities used in the past. Increase in volume of planes to be built will change the tooling and equipment radically. Present departments may have grown like Topsy, with all types of machines on hand. The physical arrangement may be awkward in present expanded departments, so that the traffic and handling elements may have a distorting effect on the time values derived from previous departmental cost figures. Naturally these provide no adequate measure of the distribution of time for work on the various machine tools, benches and other facilities.

On the other hand, if a group of estimators is set at breaking down from blueprints the operation times on various equipment for various parts, the problem of accuracy must be considered. These men must be quite familiar with processes and techniques of manufacture. Men long experienced in the operations involved may have to be brought in to advise them. They should have as much assistance as possible from time-study data derived through analyses of characteristic operations. Stop watch analysis may also be valuable to develop tables of variations in operation times reflecting increases in quantities run. Finally, some control must be set up to measure the personal factor, that is, how close the estimator comes to making his estimates approximate the times likely to occur in the work when it is performed.



Example of suggested layout for an aircraft parts-job shop. Areas alloted to machines are approximate. Frequent sequence of operations is: 1. engine lathe, turret lathe or automatic or combination; 2. milling machine; 3. drill press (sometimes milling and drilling interspersed); 4. burr bench. Accessory machine tools, such as tappers, thread mills, broaching machines, grinders, etc., are not shown.

For this purpose, all during the period of building estimates of shop loading to be used in creating the new layout, the estimators should be given blueprints of work currently routed through corresponding departments of the present shops, and a loading chart by operations maintained on this block of work as a control. As described in a previous article on loading charts, it is quite practical to check the actual times taken on such operations and to develop a correction factor for each operation group. By obtaining this trend of variation between estimated and actual times on a volume of work smaller but sufficient to show results, say once every two weeks, and applying this "calibration factor" progressively to the dated estimates for layout purposes to fit the improvement which occurs as the estimator realizes his deviations in estimating various operations, the final time data for budgeting the load on the new plant may be made reasonably dependable. This is especially true if the estimator is supplied with procedure data developed through time study and analysis anticipating improved methods to be followed in the new set-up.

Methods analyses themselves are valuable otherwise, since the layout engineer must have some authentic means of diagramming equipment, machines, fixtures, tables, work spaces, parts storage spaces, tooling services, production control arrangements, etc., which are basic to sound and economical operation.

Loading data are necessary to determine the quantity or extent of equipment or assembly lines and working spaces needed.

From the development of operation diagrams or flow charts, and quantitative loading data indicating required capacity, the next step is to make up scale-size paper cut-outs of all space-taking units and fasten them down on cross-section paper providing the same scale. This is obviously necessary in the case of machine shops and other fabricating departments where the study of various sets of parts involves compromise and revision in determining the ultimate practical layout.

This use of cut-outs is really necessary for all departments because coordination of departments follows determination of individual departmental layouts, and departments must often later be re-shaped in the process of fitting them together to create a practical flow of work as a whole and of bringing into proper contact with operations those units of engineering, tool design, experimental development, inspection, shop administration and control, and other activities which serve the work.

The result of all this care in layout, as one man aptly puts it, is that "You get a lot more work out of a lot less space."

In operation an expanded or new unit is a living thing. To be alive it

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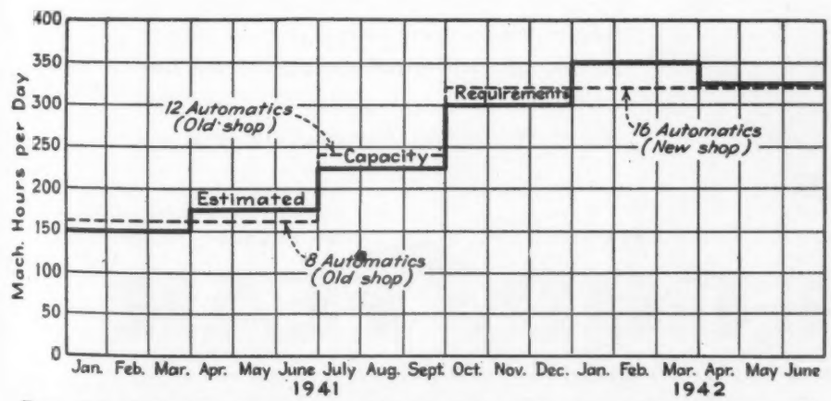
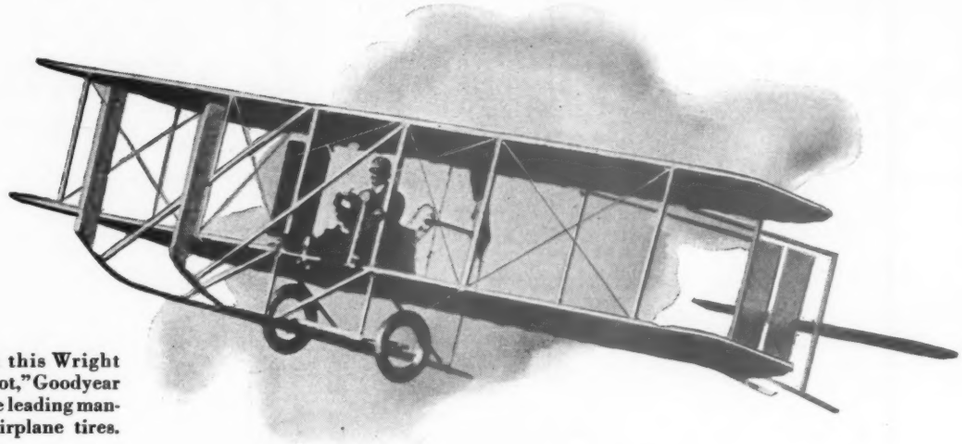


Form of load chart for forecasting equipment needs. Job shop: build load from 1940 data scaled up to increased requirements. Factory: build load from breakdown estimates of details according to airplane delivery schedule and methods analysis.



In 1912 when this Wright biplane was "hot," Goodyear was already the leading manufacturer of airplane tires.

These tires grew UP *with aviation*

Man-sized Goodyear Airwheel on substratosphere transport.

WAY back when airplanes were still using sled runners and bicycle wheels for landing gear, Goodyear first began to manufacture tires specially designed for air service. Through close cooperation with pioneer fliers we learned how to build progressively bigger and better tires to meet their needs on bigger and faster ships. And because we have continued to work in close harmony with pilots, aircraft designers and manufacturers, you will find Goodyear tires today on a very great many of the largest transports and fastest fighters. To equip these "hot" new ships Goodyear offers a complete line of tires of time-proved durability and safety—together with the tubes, wheels and brakes necessary to a perfectly balanced wheel assembly. Our long experience is at your service in solving all tire, tube, wheel and brake problems. Just write: Aeronautics Department, Goodyear, Akron, Ohio or Los Angeles, California.

THE GREATEST NAME IN RUBBER

GOODYEAR

ON YOUR NEW SHIP *SPECIFY* GOODYEAR AIRPLANE TIRES, TUBES, WHEELS AND BRAKES

Airwheel—T. M. The Goodyear Tire & Rubber Company

WESTERN AIR EXPRESS

CELEBRATES 15TH ANNIVERSARY

Oldest scheduled passenger airline in U. S.

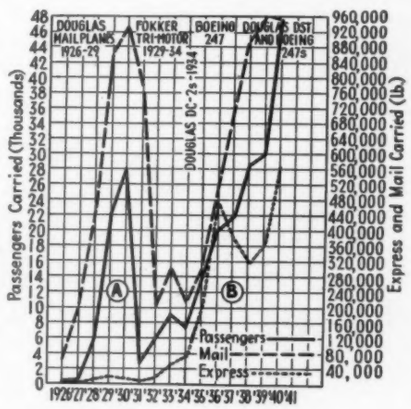
ON April 17, Western Air Express is flying the mail from Los Angeles to Salt Lake City in a Douglas transport plane, but only the old-timers will recognize the Liberty-powered biplane in which this historic packet of mail will ride. Today passengers in Douglas planes enjoy all the luxuries of the most modern transport service, but in 1926 the Douglas passengers shared their cramped cockpit with the mail bags, if indeed the mail load would permit carrying of passengers at all. Much has happened since that historic flight in 1926.

Western Air Express has pioneered or operated every airline route now flown out of Los Angeles, including the short hop service to Catalina Island. At one time Western Air operated to San Francisco, San Diego, El Paso and Dallas, Amarillo and Kansas City, and Salt Lake City. It also operated a Cheyenne-Denver-Amarillo feeder line. Airline history has been made since 1926 and most of the routes once flown by Western Air are now in the hands of other operators. But steady progress in building traffic on the main San Diego-Los Angeles-Salt Lake City-Great Falls route has brought passenger, mail, and express totals to new highs in all categories, exceeding any records made in the frenzied era of route expansions.

And expansion is again the order of the day, for WAE has been authorized to extend the Salt Lake City-Great Falls line to Lethbridge, Alberta, linking into the Canadian airline system. Other route extensions are sought by Western Air to provide local service to San Diego via San Bernardino, to Phoenix via Palm Springs, El Centro and Yuma, and a link between San Diego and El Centro. A Los Angeles-San Francisco route is also sought with one schedule being flown non-stop, and another providing service to both San Francisco and Sacramento with local stops at Bakersfield, Visalia, Fresno, Merced, and Stockton.

When Western Air inaugurated scheduled passenger service in 1926 it operated a fleet of six Douglas biplanes which cost $14,110 each. Now it operates five $130,000 Douglas DC-3s and has four more on order, plus a fleet of six Boeing 247's and one Waco for service and training. With a grant from the Guggenheim fund Western Air pioneered the operation of tri-motor Fokker transports over the Los Angeles-San Francisco route. A further pioneering step, far in advance of its time, was operation of Fokker F-32 four-engine transports over the same route. Airline fare reductions are illustrated by quoting the original round-trip fare between Los Angeles and Salt Lake City of $150, against the present tariff of but $52.12. The original staff consisted of four pilots, five maintenance men, two clerks, the late Harris M. Hanshue, president, and Major C. C. Moseley, general manager. The present staff consists of 42 pilots, 100 maintenance men, and 275 other employees. Major C. C. Moseley is now president of Aircraft Industries, Ltd., Curtiss-Wright Technical Institute, Cal-Aero Academy, and Polaris Flight Academy, all of Glendale, Calif. Present head of the Western Air Express is William A. Coulter, president. On April 17, the name Western Air Express Corp. will be changed to Western Air Lines, Inc.

W. A. Coulter



Western Air's Progress

WAE. started service with these pilots in 1926. Left to right: Fred Kelly, Jimmie James, Al Da Garmo, Maurice Graham, C. C. Moseley, mgr.

"One nation indivisible", is America's song of industry, echoed by singing rails, humming highways and the drone of air transports overhead. In this hour of destiny Douglas is proud to re-double every effort assuring America's military air supremacy and proud to have built the equipment with which our airlines join surface communications to get the job done. Douglas Aircraft Company Inc., Santa Monica, Calif.

DOUGLAS

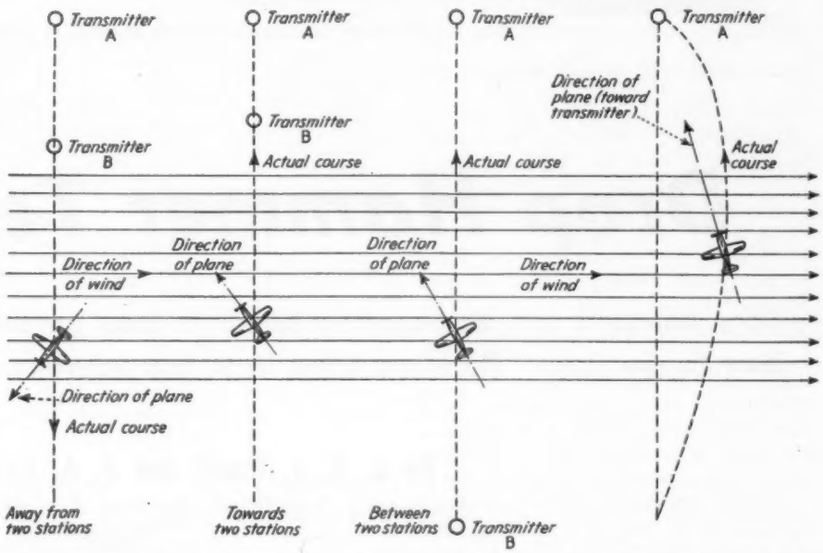
FIRST AROUND THE WORLD — *first* — IN NATIONAL AIR DEFENSE

Harvey Directional Automatic Radio Control

A radio "homing pigeon" makes directional flight operation entirely automatic

WIDELY demonstrated in flight tests, the Harvey Directional Automatic Radio Control has repeatedly shown its ability to fly an airplane along a straight-line course joining any two radio stations, despite cross-wind conditions. Operation is entirely automatic insofar as directional control is concerned. The pilot or navigator simply tunes the desired stations, sets the control to fly to or away from one of the stations, and then leaves the navigation problem to the radio control equipment.

The radio device, operating on the geometric principle that opposite angles of two intersecting lines are always equal, brings the plane to the desired course and holds it on this course by means of a servo motor attached to the rudder controls. Navigation is accurate to within 1 deg. for any point on the course, and becomes absolutely precise as the home station is approached. Hunting along the course is eliminated by a proportioning system which provides amplification inversely proportional to signal strength. Thus a plane 10 deg. off course receives twice the rudder action it is given when only 5 deg. off course, and as the plane approaches its true course rudder action is proportionally decreased until it flies directly towards the transmitter.



Diagrams illustrating the difference between the Harvey device and the homing radio equipment now being used.

However "straight ahead" may actually mean that the plane is crabbing sharply along the course in order to correct for wind drift. This action is entirely automatic.

In theory and construction the Harvey Radio Directional Control is a combination of two "homing" radios. Either of the two radios may be used as an ordinary homing device and will fly the plane directly to the station selected, though not on a straight line.

When both sets are used the plane may be flown along any straight line intersecting two selected stations, whether these stations are both ahead of the plane, both behind it, or one on either side. In operation the two receivers are connected through a balancing circuit so that one signal is opposed to the other. As long as the plane is on course the difference between the two angles formed by the intersection of the plane's longitudinal axis with the line of the course will be zero, no matter how the plane may be headed to correct for wind drift. As soon as the plane departs from true course these angles

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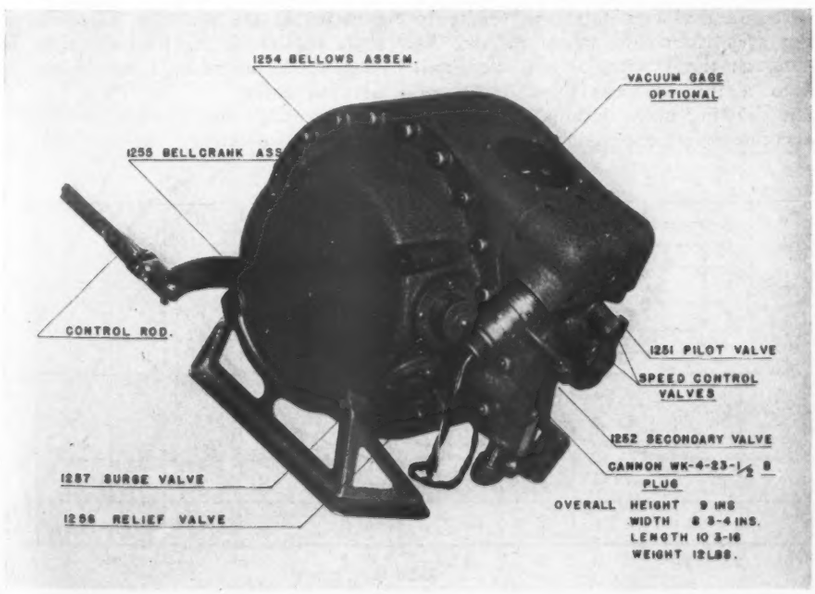

Servo motor, controlling rudder action, is actuated automatically by radio signals.

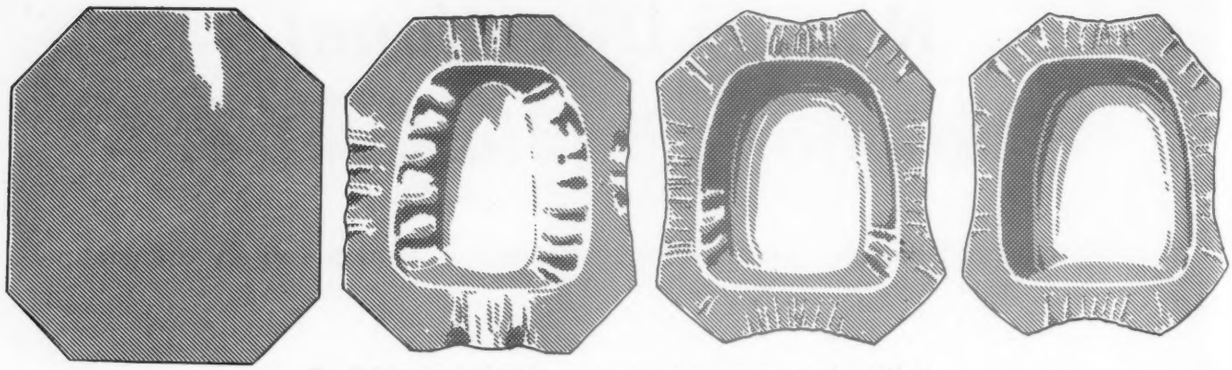

Fig. 1. Progressive forming on the drop hammer to control wrinkles.

Drop Hammer Technique

Drop hammers are an important factor in mass production. Equally important is how to use them. Here are some facts and figures on the operation at Lockheed.

By J. S. J. Hlobil and J. A. Petrie

Engineering Department, Lockheed Aircraft Corp.

EVERYONE in the aircraft industry knows about drop hammers and the increasing role they play in putting over the production program. Lockheed Aircraft alone has installed, in a new building erected for this purpose, a battery of eleven drop hammer presses, of which ten are rope drop hammers of Lockheed design, and one a Chambersburg Ceco Stamp, pneumatically activated.

As it is, therefore, already an important soldier in national defense, the basic principles of drop hammer forming and technology, and die-cast making, need hardly be explained. In the following article there will be presented detailed information on drop hammer methods, including finishing operations on drop hammer parts, and design rules developed from actual practice.

Drop Hammer Technique

To facilitate the flow of sheet metal, it is common practice to employ some lubricant such as vegetable oils or special drawing compounds. If the desired form is such that there exists a possibility of the metal tearing or developing folds, rubber blocks may be used to assist in preforming, and gradual working of the material may be necessary. In other cases, progressive drawing will provide a suitable solution. Progressive drawing is achieved by the use of stripper rings, wooden laminations, or pressure pads. The maximum depth of drawing is contingent upon successful control of wrinkles which develop in the sheet metal, especially in the area around the top of the die. As long as these wrinkles are converted into a thicker gage by "shrinking," the drawing may continue. The three mediums mentioned above make possible close control over the various degrees of forming.

Quite often the use of progressive dies is advisable as a means of controlling forming, especially in connection with severe draws. (See Figs. 1 and 2.) Progressive dies are simply modifications of the final die which impart some portion of the final shape to the sheet metal before it is struck into the finished shape.

Progressive dies are not particularly expensive, owing to the fact that no

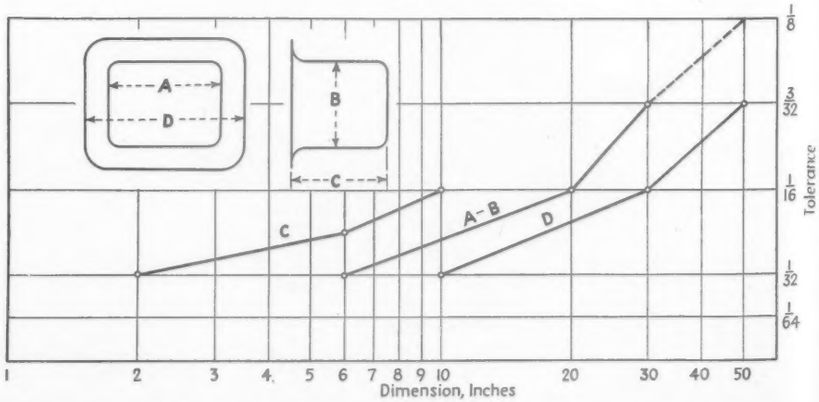

Chart I. On this chart are given the approximate tolerances recommended for use with drop hammer parts, according to their respective sizes.

particular exactness of dimension or contour is required. Any approximate shape that brings the sheet metal a step closer to the final shape, avoiding undue wrinkling, will be acceptable. (Approximately three preforming dies may be made for the cost of one final die.) A further advantage lies in the fact that preforming dies will prolong the life of the expensive final die thus making for greater economy.

Here, the time required to change the dies has to be considered. According to the Lockheed industrial engineering department, studies made on the drop hammer indicate set-up and tear-down average allowances of 27.7 min.

The weight of the punch and die sets observed range from 654 lb. to 7,300 lb. If the punch and die sets are classified by weight, the following allowances are obtained.

Weights	Set-up and Tear-Down
Under 1,000 lb.	18.7 min.
1,000 to 4,000 lb.	23.8 min.
Over 4,000 lb.	32.1 min.

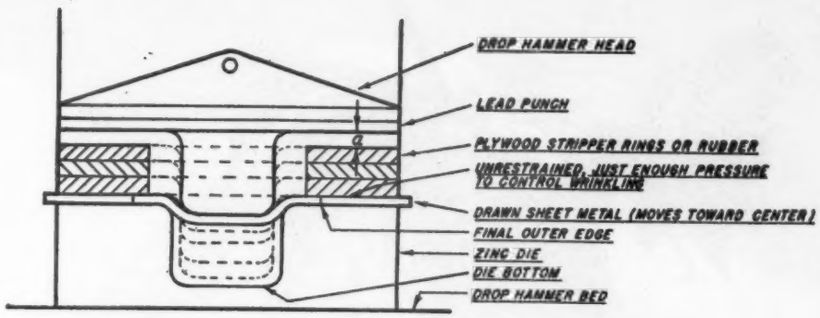

Fig. 2. Examples of preforming dies.

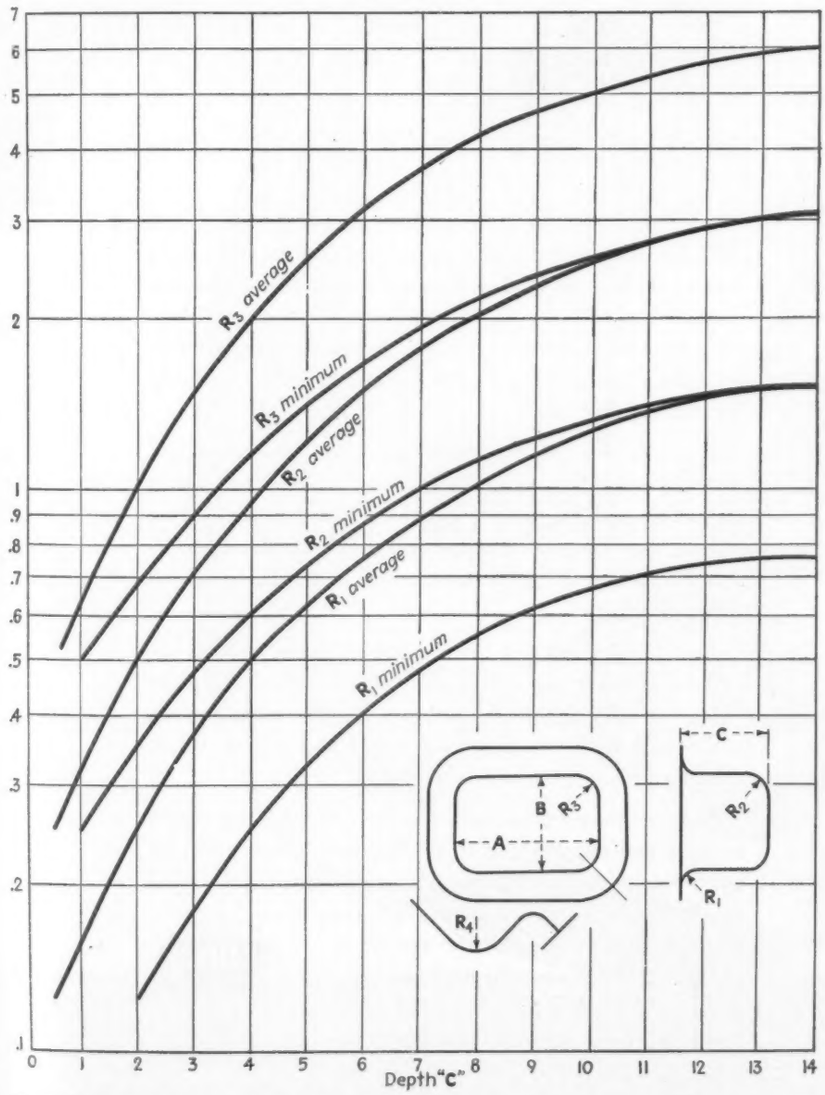

Chart II. Illustrating the relative size of radii required under certain conditions and the approximate radii recommended as governed by size of finished part.

Finishing Operations on Drop Hammer Parts

Very often, parts formed in the drop hammer will require additional finishing, especially along the edges of flanges or in areas where we feel drawing occurs. These areas are straightened by reworking with a hand hammer or a speed hammer. Three such speed hammers are at present maintained in the Lockheed shop. Such "retouching" of parts is comparatively simple and inexpensive.

Drop-hammer-formed parts are made from annealed stock if the metals have a tendency to work-harden, and particularly if stainless steel is used. It is quite often necessary to anneal parts one or more times before the final shape is reached. Parts made from annealed metals having heat-treatable characteristics are heat-treated to the desired strength after forming.

After heat-treating drop-hammer-formed parts, it is general practice to restrike immediately these parts before the material can develop its full hardness. This is necessary because of a tendency of the formed parts to warp out of shape during heat-treatment. Restriking insures that finished parts will correspond to the contours of the zinc or kirkstie dies.

Contrary to hydro-press practice,

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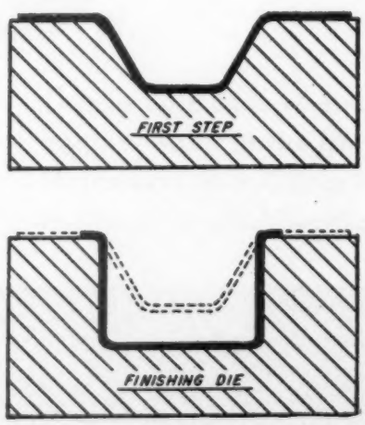
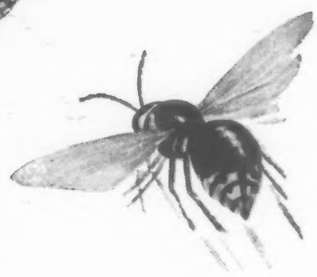
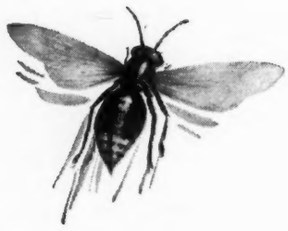


Fig. 3. Drop hammer forming.

Home Defense





THE Paper Hornet is really a good-natured creature, content to buzz around of a summer's day looking for his dinner. But nobody in his right mind would deliberately invade a hornet's nest. Mr. Hornet long ago developed aerial home defense tactics so effective that he rarely is called upon to fight.

But it is not only his sting that earns him the respect of the world—for many insects carry weapons. He is also an amazing flyer. He has the power to take off in a second, quickly gain altitude and execute a neat power-dive to intercept the attacker before he quite knows what struck him.

Just as the power of his wings aids the hornet in the defense of his home, so too may more powerful engines aid in our own defense. The more power American engines can deliver for every pound of weight and gallon of fuel, the more readily can we resist attack.

Since increased power must come through refinements in fuels and engines, the Ethyl Gasoline Corporation regards the research work which its engineers are privileged to conduct in cooperation with aviation technologists as being of the utmost importance. We regard the technical data constantly being developed as an essential link in our national defense armor.

ETHYL

ETHYL GASOLINE CORPORATION, *manufacturer of anti-knock fluids used by oil companies to improve gasoline*

Every important **aircraft engine made in the United States uses M-R-C Bearings in the most vital positions.**

MARLIN - ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, N. Y.

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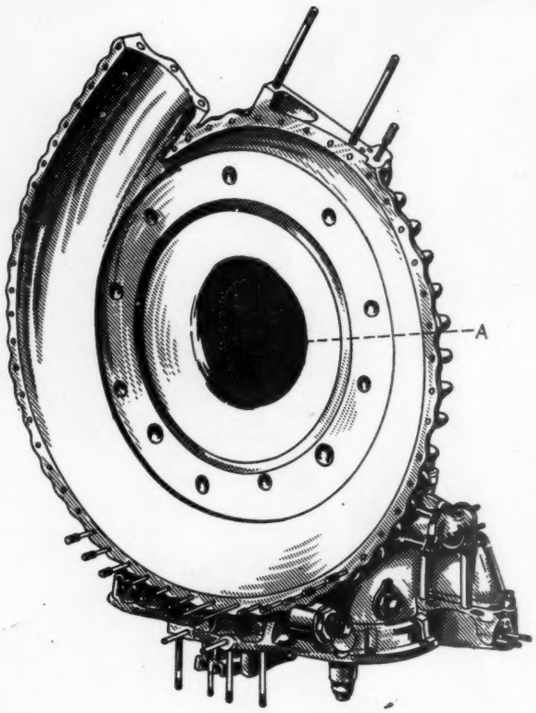
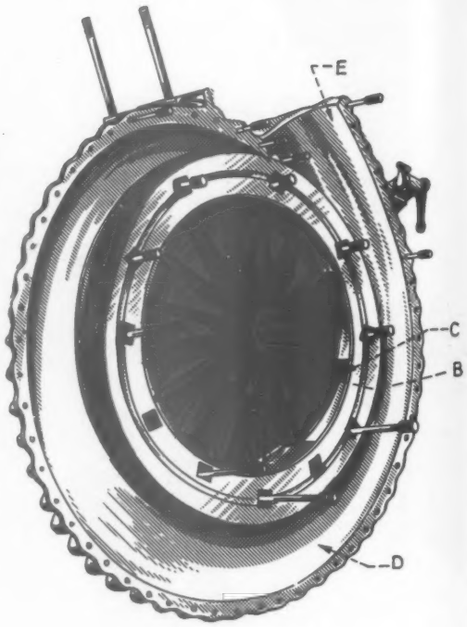
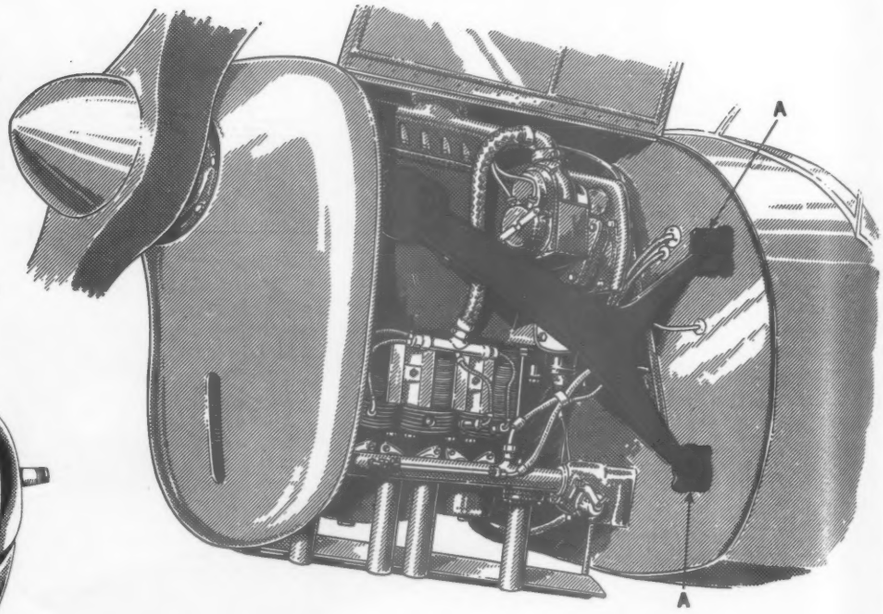
AVIATION SKETCH BOOK OF DESIGN DETAIL

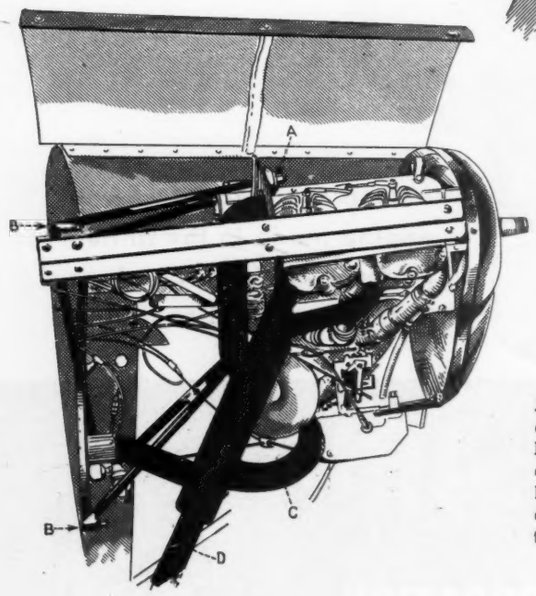


At the left and right are cross sectional views of the supercharger drive of the Rolls Royce Merlin engine. It consists of a high speed centrifugal blower, mounted co-axially with the crank shaft driven from its through speed multiplying gears. A forged aluminum impeller "B" with separate steel inlet guide vanes is splined to the rotor shaft and secured to it by ring nut and annular steel wedges. The rotor shaft is carried at its forward end in a ball bearing and at its rear end in two spirally-grooved floating bushes. Air is drawn in through "A" and after passing through the impeller "B" travels out through the outlet "C" into the chamber "D" which supplies the cylinders through "E".



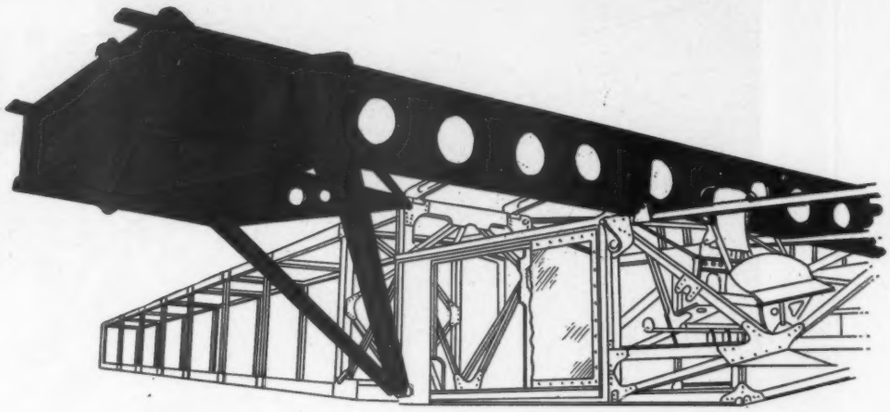
At the right is shown the Hirth Engine type HM50482 installed in the German Arado AR79. The engine mount, in blue, is of forged steel mounted to the fire wall by two easily detachable fittings at "A" and to the engine by the two vibration dampening shock absorber units in the motor.

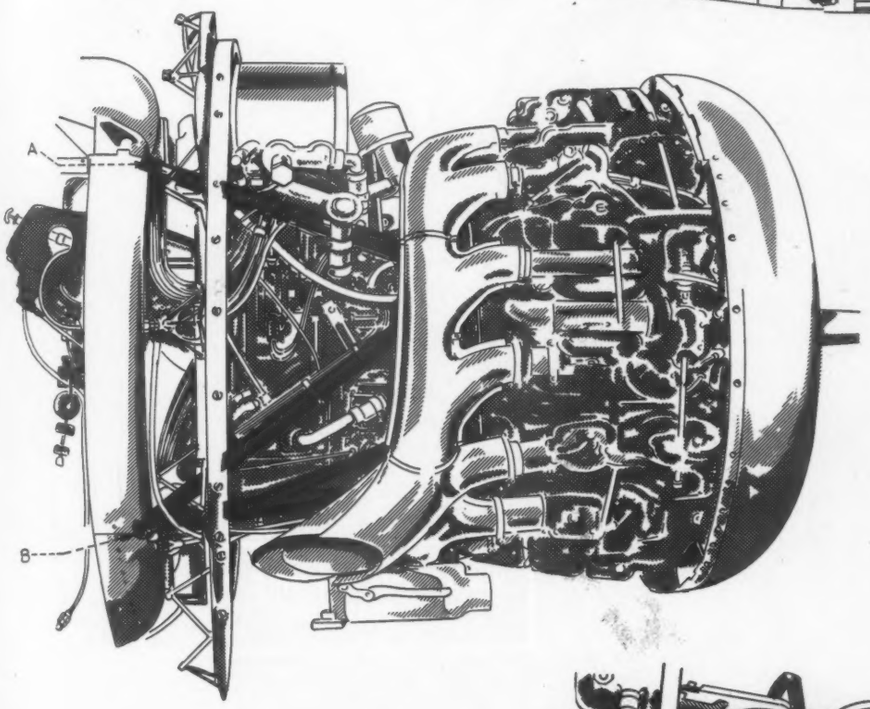




At the left is a Continental 75 hp. engine installed in the Summit HM-5. The engine is attached at two upper points "A" and two corresponding points below. The mount is attached to the fire wall at four points two of which are shown at "B". The exhaust system "D" outlined in blue has the cabin heater manifold round the exhaust pipe with the air intake at the top and exits into the cabin at the bottom. "C" is the connecting pipe to the opposite two cylinders.

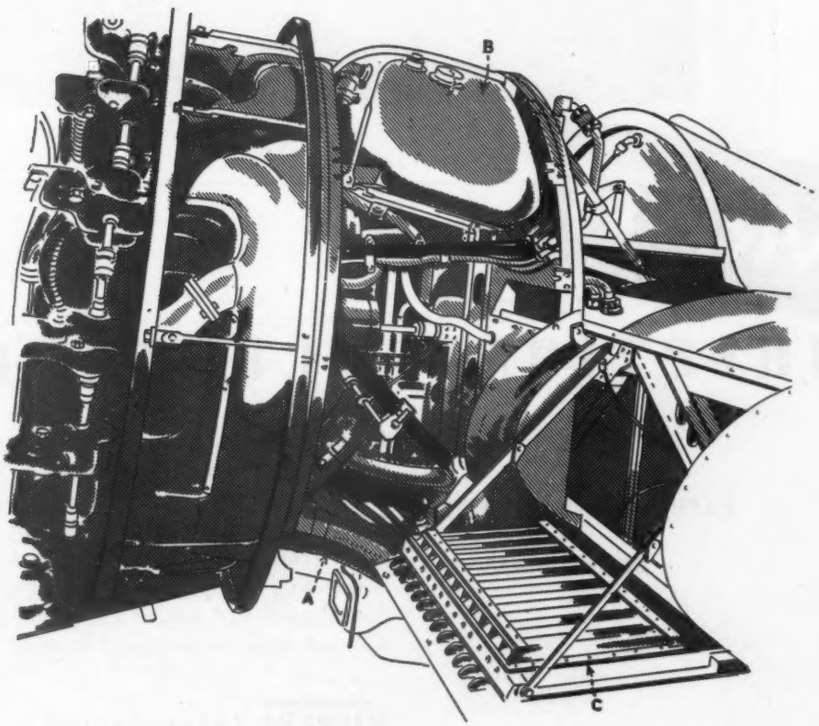
At the right is the point of connection of the main wing spar of the Hanriot 510 with the fuselage. As shown the front wing spar is one solid piece while the rear spar is cut into two sections each joined at the side of the fuselage to a reinforced bulkhead. This rear spar construction uses a semi-cantilever principle with much of the stress being taken by the strut to the bottom of the fuselage.





The power plant of the Vought V-156, at the left, is removable in one unit. It includes the engine, propeller, all engine accessories, starter, generator, fire wall, oil system complete, including cooler, fire extinguisher, cowling supports and all engine instruments. By breaking only 18 quick release connections and removing 4 bolts (two of which are shown at "A" and "B") attaching the engine mount, the entire power plant unit may be removed in a relatively short time. This makes it possible to quickly install a complete spare power plant unit in the event of trouble with any of the major units involved.

The engines of the Sikorsky S42, at right, are mounted in their wing nacelles on welded steel engine mounts. Either of the two engines on either side of the center line of the ship are interchangeable as they are designed to permit removal of the engine mount and engine as a unit. The oil tank is located above the mount at "B" with the exhaust outlet at "A". "C" is a collapsible step in the leading edge of the wing for mechanics to use when repairing the engine.



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Exceptional Durability

Leak-Proof

Positive sealing . . . of poppet type construction, this Vickers valve is leak-proof and has integral thermal relief. Exceptional durability is another feature; alloy steel inserts are used for valve seats and poppets. The manifolding design permits removal of individual units (containing all moving parts) for replacement without disconnecting any piping. Precision engineered by America's largest manufacturer of power hydraulic devices, the Vickers Directional Control Valve is designed to meet rigid requirements.

VICKERS *Incorporated* • 1460 OAKMAN BLVD.
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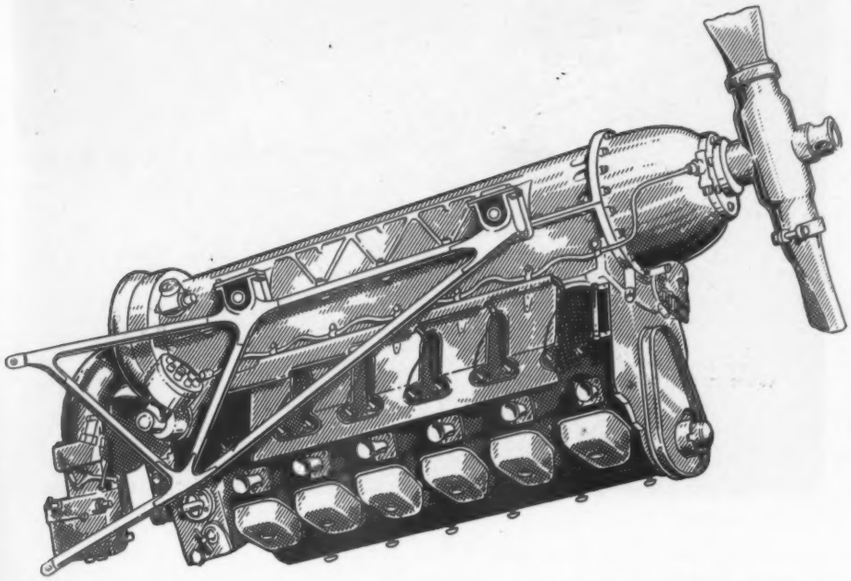
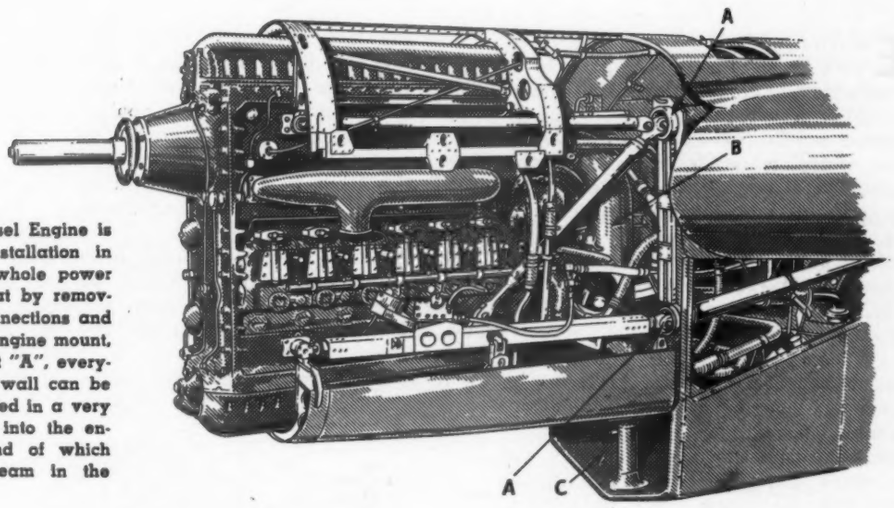
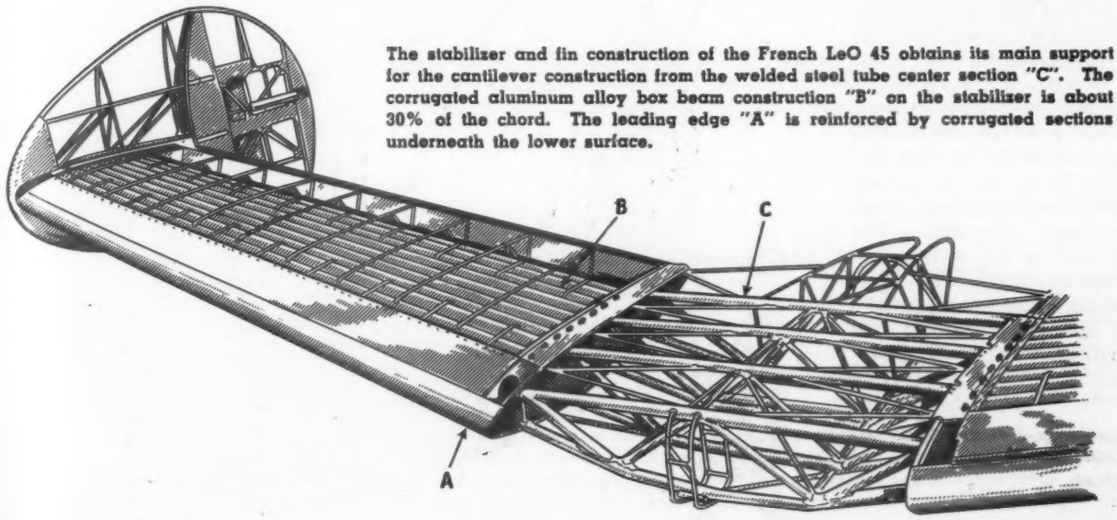


The Czechoslovakian engine, the Walter Sagitta II is rated at 460 hp. Although the installation drawn was from another model this engine was used in the Fokker D-23 developed previous to the war. The engine is supported from the crank case on top by four supports two on each side, and the mount illustrated is of welded chrome molybdenum steel tube construction with reinforcing plates welded at each joint.



The Junkers Jumo 205 Diesel Engine is shown in its familiar installation in the Junkers Ju 86. The whole power unit has been built so that by removing comparatively few connections and undoing four bolts of the engine mount, two of which are shown at "A", everything forward of the fire wall can be removed and a unit installed in a very short time. Air is taken into the engine through "B" the end of which projects into the air stream in the opening "C".



The stabilizer and fin construction of the French LeO 45 obtains its main support for the cantilever construction from the welded steel tube center section "C". The corrugated aluminum alloy box beam construction "B" on the stabilizer is about 30% of the chord. The leading edge "A" is reinforced by corrugated sections underneath the lower surface.

Hoisting one of the Wright Duplex-Cyclone engines into the Douglas B-19, which uses one of the latest type engine mounts.

By H. V. Shebat

Test Pilot,
Wright Aeronautical Corp.

Dynamic engine suspension has been in use for several years. Here is a story on its basic theories and why it was designed.

Dynamic Engine Suspension

ENGINE mounts of ten years ago were as rigid as it was possible to make them. No elasticity was intentionally provided, and the severe response to vibration extended throughout the entire operating range. For the past several years it has been a general practice to intentionally provide some elasticity in engine mounts. This has been done by means of rubber bushings inserted either between the engine and the mount or between the mount and the airplane or both.

When elasticity is built into a motor mount, one basic requirement must be met. The engine must be held in one position firmly enough to permit satisfactory attachment of the plumbing, the controls, and the cowling, and also to transmit the thrust. The methods of using rubber cushions (compression and shear units) for this purpose are many and varied, but all of them meet this one basic requirement in the same manner—the location of the engine as a whole is fixed by giving a fixed location to each point of attachment. Thus the engine cannot move fore and aft as a whole or in any part; that is, it has little or no rotational (yawing and pitching) elasticity. The elasticity provided is not such as to prevent transmission of vibration exciting forces which appeared as couples or as forces applied away from the center of gravity.

So any force tending to shake the engine, up and down, or sideways, also tends to rotate it in yaw or pitch, unless the force happens to be applied at the center of gravity. Conversely, any force tending to produce yaw or pitch also tends to produce a shaking force. This condition is technically known as "elastic coupling". If the rotating tendencies are divorced from the shaking tendencies, each can be treated separately by the designer, and we have a condition known as "decoupled".

In order to understand the conditions let us sum up the demands we make upon the motor mount:

1. An engine must be attached to an airplane structure.
2. The engine tends to vibrate and shake on three axes, and angularly in torsion, pitch, and yaw.
3. At all frequencies which occur during normal operation, the engine should have freedom to exhaust these tendencies to vibrate without transmitting the vibration exciting forces to the plane structure.
4. The attachment must be sufficiently rigid to transmit the thrust developed,

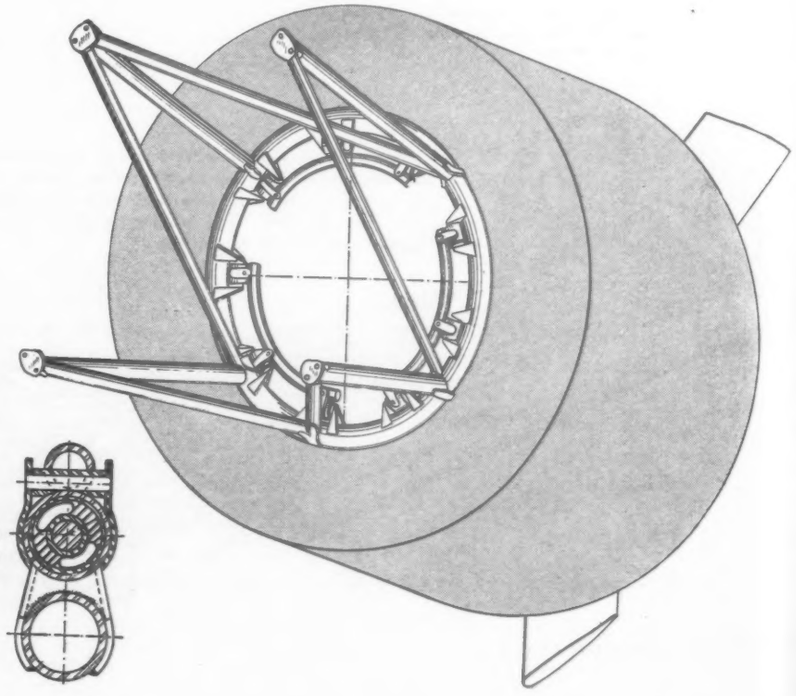


Fig. 1. Conventional Motor Mount as used on Curtiss-Wright Condor planes with Cyclone Engines.

and the safe attachment of all plumbing, controls, cowling, etc.

Conventional motor mounts have flexibility introduced to permit torsional vibration to exhaust itself, but they have rigidity built in to resist vibration in yaw and in pitch. This resistance not only transmits to the plane structure the forces tending to produce vibrating in yaw and pitch, but within the power plant it converts these forces —excitation of yaw and pitch—into shaking forces and vice versa, thus multiplying the frequencies at which exciting forces of every type appear.

About three years ago the increasing power per engine and per cylinder made it necessary to seek a better answer to the question "What can be done

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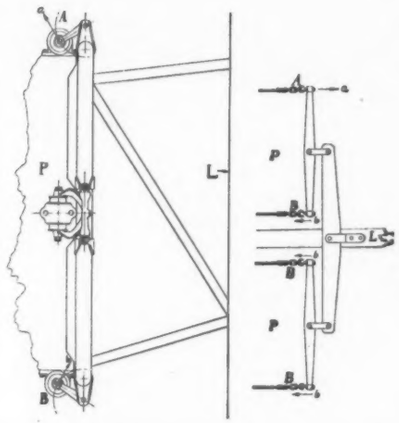


Fig. 2. Descendant Dynamic Suspension (in Principle, Left) Ancestor Whiffle-Tree (Right) Note that in both sketches any point "A" can move in any direction "a" without disturbing the relationship between load "L" and power "P" (the C.G. of the power plant), provided point or points "B" move in the direction of "b" enough to compensate for the movement of "A".

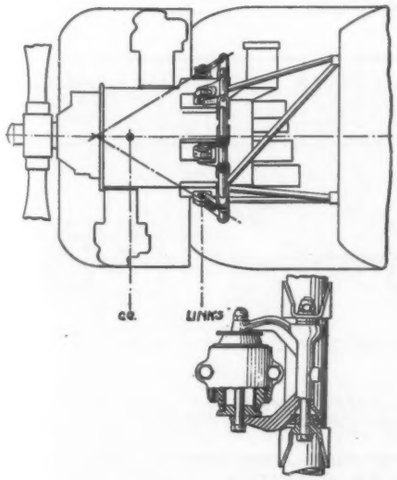


Fig. 3. Dynamic Suspension. Note that the links constitute a pin pointed structure giving the equivalent of support at the intersection of their centerlines, which is in front of the c.g. of the power plant.

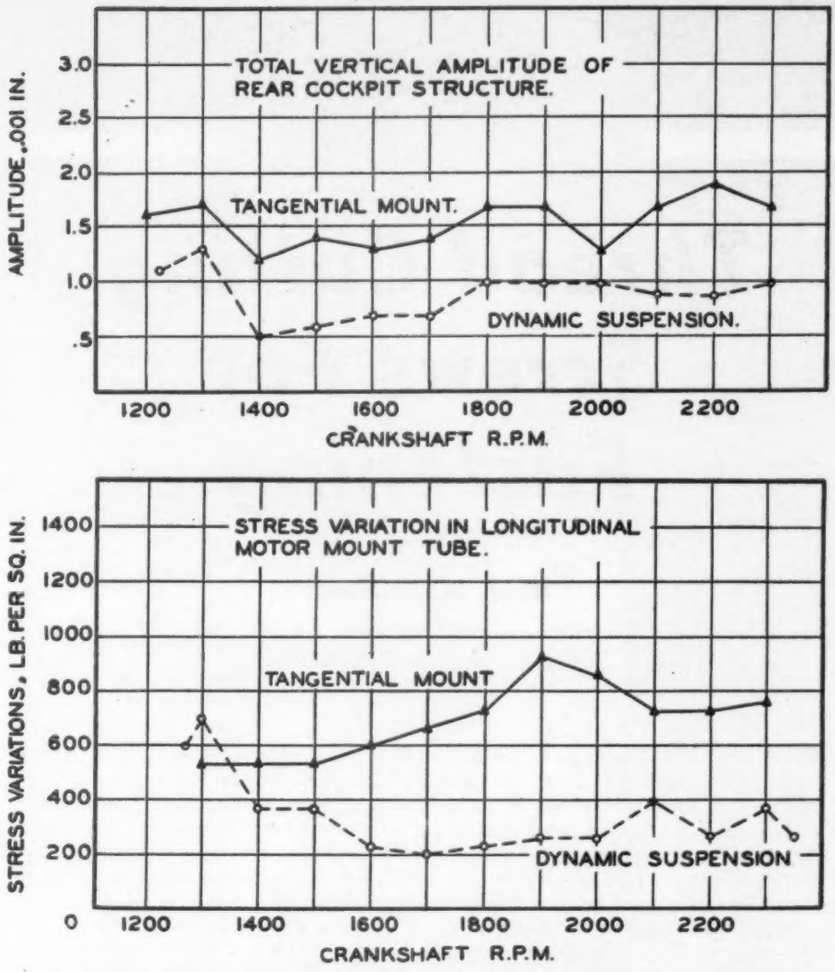


Fig. 4. Curves showing movement in the pilot's seat and stresses in a motor mount member with a conventional rubber mounting and with dynamic suspension links, on the identical rubber cushions.

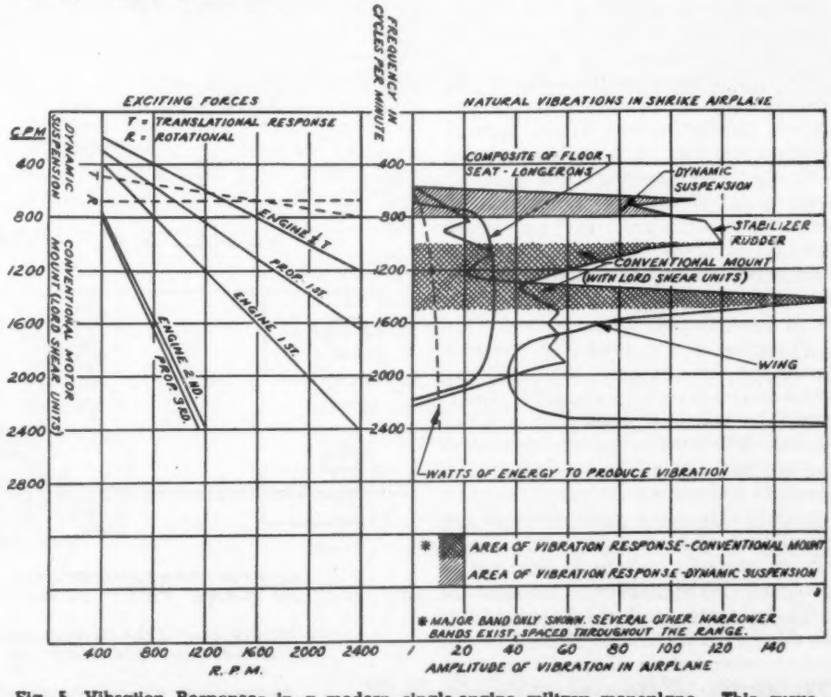
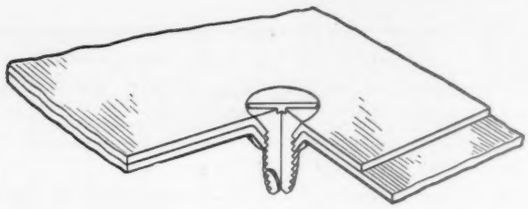


Fig. 5. Vibration Responses in a modern single-engine military monoplane. This curve gives a comparison of the vibration responses (actually measured) in a plane with: 1st, A rigid mount which responds throughout the entire range of frequencies from idling to rated rpm. 2nd, A conventional rubber cushioned mount which responds throughout the large band which is heavily shaded and several small bands which are not shown. 3rd, Dynamic suspension, which responds only within the small band (lightly shaded) at speeds which are of little or no importance.



Thread Cutting Screws For Fastening

By J. B. O'Connor

Sales Engineer
Shakeproof Lock Washer Company

THREAD-CUTTING screws, long regarded as ideal for many primary fastenings in the manufacture of automobiles, rail cars and other vehicles, may, on the basis of recently concluded tests, find their usefulness vastly expanded in their most recent field of operation—aircraft construction. These tests bring to light certain interesting results by making a comparison between the holding ability of thread-cutting screws and aluminum alloy rivets.

Although this type of screw has already been approved for secondary or non-vital attachments in government aircraft, acceptance in the industry for primary or semi-critical joints has lagged, largely because of the lack of comparative data. Not to be confused with the wood-screw thread type of sheet metal screw, the thread-cutting screw taps standard machine screw threads in metal that has been previously punched or drilled, and provides secure fastening by virtue of its tight fit in these threads.

Recognizing the need for cautious procedure in studying the problems peculiar to aircraft construction, utmost care was taken in developing a series of tests calculated to provide data bearing on joint failures due to shear, axial tension, and vibration.

Test joints were made to represent attachment of fuselage or wing skin to rib or stiffener members. Because of apparent aerodynamic advantages of flush fastenings and the existing data on flush riveting it was decided to test only countersunk or dimpled fastenings. The selection of joints was made with two objectives; first, the joints represented pr. ary fastenings, and second, they were in a range of material thickness critical for screws. Thin aluminum alloy materials were used, since attachments in thicker sections would obviously show advantages for the relatively stronger steel thread-cutting screws over aluminum alloy rivets. Such tests would then illustrate the comparative integrity of this type of "threaded" fastener against "upset" or "headed" fasteners.

The screws used were of a type having a single thread-cutting slot. They were made of X-1020 SAE steel, heat treated and cadmium plated. The structural metal used was 24ST Alclad aluminum alloy and two thickness ranges employed; skin .017 in. thick fastened to stiffener .024 in. thick, and skin .020 in. thick fastened to stiffener .032 in. thick. Rivets used were AN-425, A17S aluminum alloy. 3/32 in. and ⅛ in. countersunk rivets were compared with No. 4 and No. 6 flat head screws.

The performance of tests adhered as far as possible to accepted methods. Axial tension tests conformed to the method advocated by the U. S. Bureau of Standards and the U. S. Army Air Corps. Shear tests were made in a Tinius Olsen tension machine in a regular manner except that standard serrated wedge type jaws were replaced by jaws which formed a semi-circular holding bead in the test strips. This innovation allowed pre-gripping of the aluminum alloy test strips before the pull loads were applied—thus eliminating slippage.

All axial tension and shear tests were continuously recorded as elongation occurred under load. Two typical load elongation curves are shown on the accompanying diagram together with the maximum ultimate loads held by riveted and screw fastened joints.

Comparisons were intended between standard screws and rivets having 80 deg. head angles; but additional test data is included showing performance of screws with 100 deg. head angles.

A method of producing failures by vibration was a matter of concern, but the eventual decision was to produce vibratory stresses extreme enough to cause fairly prompt failures. Test strips provided for equal load distribution between two joints; one joint fastened by

(*Turn to page* 158)

IT ISN'T IN THE BOOK

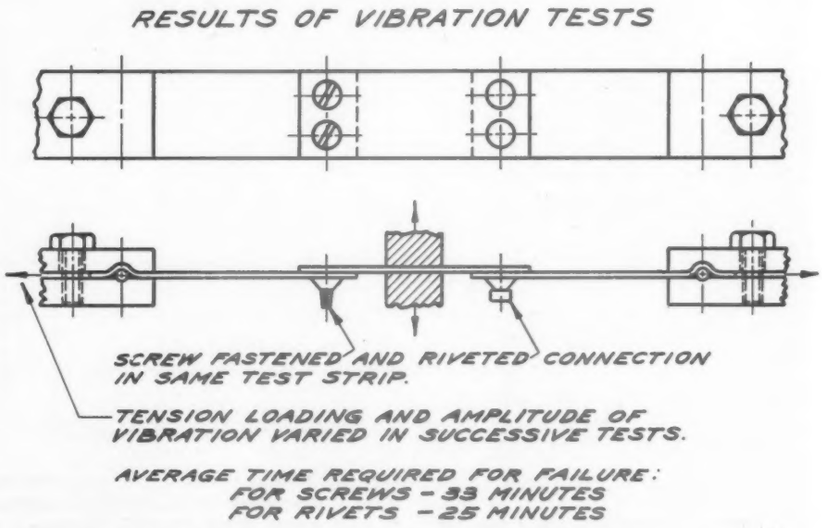

RESULTS OF VIBRATION TESTS
SCREW FASTENED AND RIVETED CONNECTION IN SAME TEST STRIP.
TENSION LOADING AND AMPLITUDE OF VIBRATION VARIED IN SUCCESSIVE TESTS.
AVERAGE TIME REQUIRED FOR FAILURE:
FOR SCREWS - 33 MINUTES
FOR RIVETS - 25 MINUTES

Fig. 1. Drawing of the test specimen as mounted for the vibration test.

An Eye to Perfection

Before a Wright Engine is assembled, nearly 45,000 mechanical inspections of the separate parts assure unvarying quality.

Under a trained eye and a jeweler's glass this Cyclone crankshaft is facing a searching examination which climaxes 850 pre-assembly inspections — inspections which insure flawless material and precise dimensions. Approved, it must prove itself still further on the test stands before final acceptance.

With more than 1,200,000 H. P. a month being produced — a figure which will be doubled during 1941 — there has been no relaxing of vigilance, no compromise with quality. Six great Wright plants are engaged in unprecedented mass production... of the finest aircraft engines possible.

Wright Aeronautical Corporation, Paterson, New Jersey
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WRIGHT
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HALF A CENTURY OF KEEPING FAITH
ESTABLISHED
1889
FIFTY YEARS OF PROGRESS

Flying EQUIPMENT

Curtiss Navy Dive Bomber

Built for shipboard operation

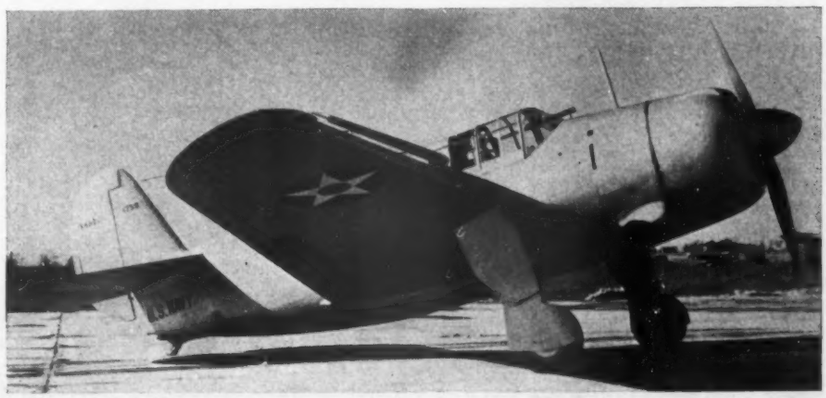
A NEW dive bomber said to be the fastest and the greatest load carrier of its class anywhere in the world was announced last month by Curtiss-Wright. Known as the Curtiss XSB2C-1, the plane has a 1700 hp. Wright Cyclone engine and was built in direct response to requests by the Navy.

The ship is a two place, all-metal, low-mid-wing monoplane. While performance figures are withheld, the airplane was built after the Navy had requested a dive bomber that could carry twice as many heavy bombs as any existing dive bomber, fly twice as far, remain in flight four and one-half hours longer than present models, develop a speed of 100 m.p.h. more than today's dive bombers, with twice as much armament and greater fire power. This was a tall order and apparently Curtiss-Wright was able to fulfill it.

As it is built to fly from the decks of carriers, the plane has folding wings for storage below decks. It is considerably larger than most single-engine ships, yet it has a fast take-off and is maneuverable in flight.

With all of Curtiss' engineering skill behind it, the new plane has been designed for mass production. It will be built at the company's new plant at Columbus, Ohio, where 1,156,000 square feet of floor space is being completed. Curtiss built the first Navy dive bomber in 1930, which was called the Hell Diver.

Chief test pilot Lloyd Child inspects the ship. Note unusual size of plane. The huge bomb load which this ship can handle is carried inside the fuselage.



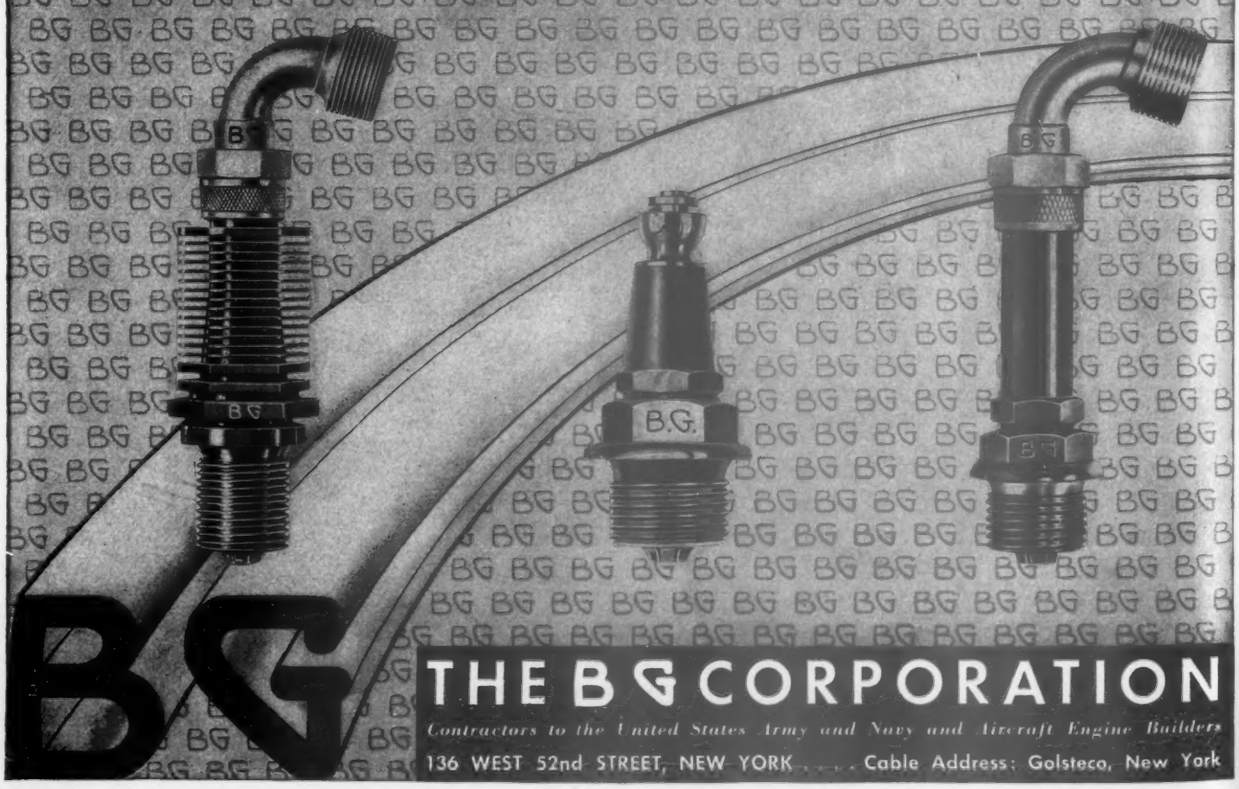
New plane is reported to be most efficient of its type anywhere in the world. Notice the movable retractable slot in the wing tip.

There is a

BG

SPARK PLUG

for every type of aviation engine



THE BG CORPORATION

Contractors to the United States Army and Navy and Aircraft Engine Builders

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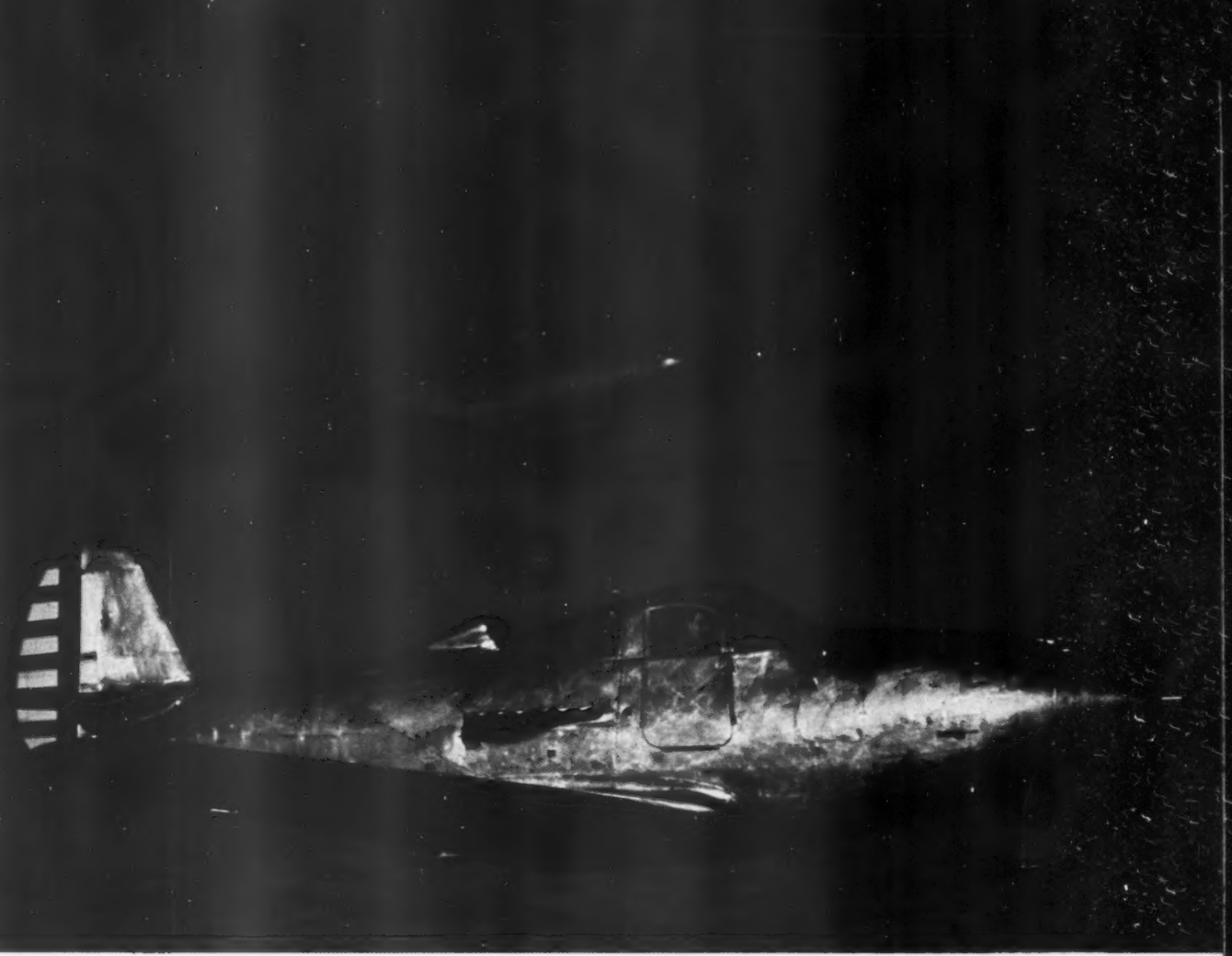

Spearheads of Defense

SWIFT in action, deadly as its namesake, the Bell Airacobra, with an aircraft cannon firing through the hub of a specially designed Curtiss Electric Propeller, is an effective new weapon of defense.

Designed for high performance and maneuverability, the P-39 adds new fighting power to the U. S. Army Air Corps and the Royal Air Force.

CURTISS PROPELLER DIVISION
Curtiss-Wright Corporation • CALDWELL, NEW JERSEY

Bell P-39 for Army Air Corps

UNIQUE TO BOTH THE AIRACOBRA AND THE AIRACUDA ARE THE EXTENSION SHAFT-MOUNTED PROPELLERS, DRIVEN FROM REMOTE ENGINE LOCATIONS.

CURTISS *Electric*
PROPELLERS

*The Thundering Herd**

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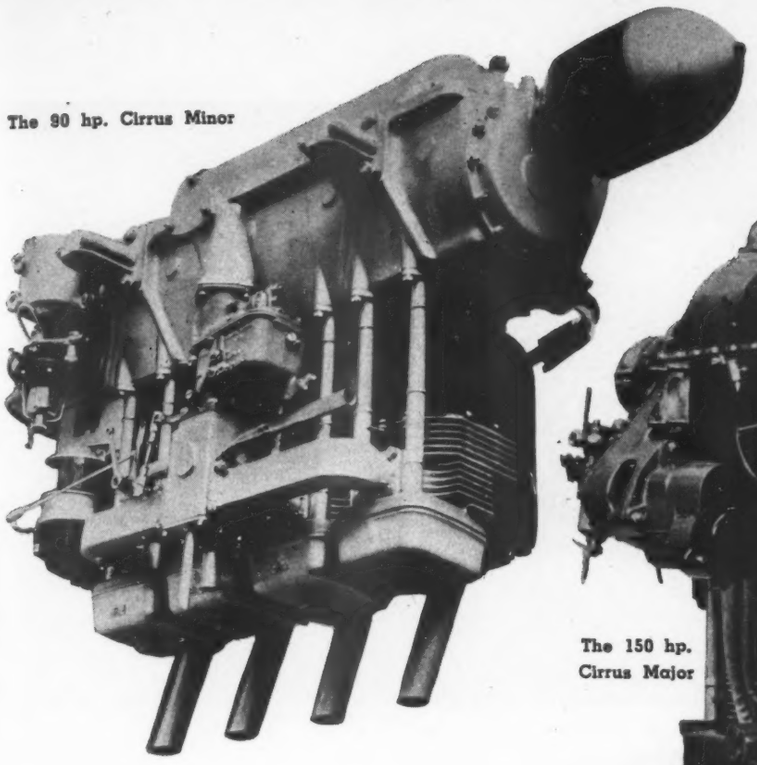
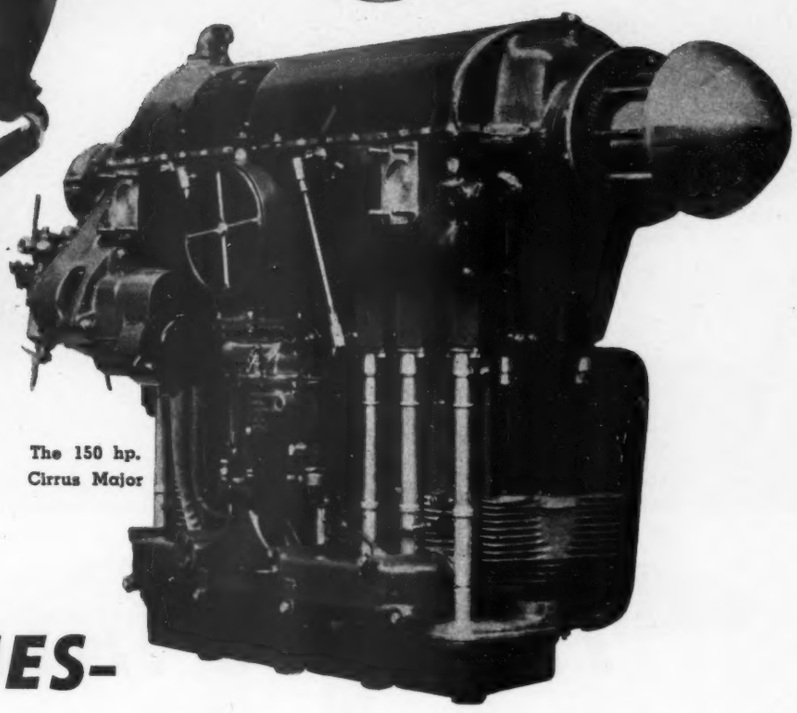
*BREWSTER BUFFALOS ON DUTY WITH THE R.A.F.

FIGHTERS AND DIVE BOMBERS ★ *for Lasting Mastery of the Air*

FOREIGN EQUIPMENT



The 90 hp. Cirrus Minor



The 150 hp. Cirrus Major

CIRRUS ENGINES—MAJOR AND MINOR

Many pre-war English lightplane engines are serving a vital purpose in their present training program. Two such engines are the Cirrus Major and Minor, of inverted air-cooled in-line design

THE four-cylinder, inverted in-line, air-cooled Cirrus Major and Cirrus Minor engines manufactured in England by the Cirrus Engine Department of Blackburn Aircraft Ltd., are well-known for their achievements in small airplanes. Due to its greater power output, the 150 hp. Cirrus Major is more extensively used than the 90 hp. Cirrus Minor at the present time. The Cirrus Major is used in Miles Magister trainers supplied to the Royal Air Force and it also powers the Percival Gull, the General Aircraft Cygnet and the new General Aircraft Owlet day-and-night trainer equipped with tricycle landing gear.

The construction of the two current models of the Cirrus is conventional. In the case of the Cirrus Major, the crankcase is made of R. R. 50 Hiduminium (aluminum alloy) and there is a domed cover plate of .Elektron (magnesium alloy). The cylinder barrels are machined from steel forgings with cooling fins and have a flange on each end. One flange is used to attach the barrel to the crankcase with four studs and nuts while the other one on the opposite end of the barrel has twelve studs for attaching the aluminum alloy cylinder head. A laminated copper washer has been found to be quite satisfactory for making a gas-tight joint between the steel barrel and the aluminum alloy head.

The crankshaft with its four throws is machined from a nickel-chrome vanadium steel forging. It is carried in five plain bearings and has a large diameter thrust bearing at the front end. It is drilled for pressure lubrication and carries a starter engagement pinion on its rear end. The connecting rods are machined from Hiduminium L. 40 forgings of heavy section and are fitted with white metal steel-backed bearings in their big-ends. The pistons are made of "Y" aluminum alloy and are of the slipper type with floating piston pins. Two compression rings and one oil scraper ring of the tapered type are fitted to each piston. The camshaft for the valve gear is carried in five plain bearings.

The valves, one for inlet and one for exhaust, are actuated by means of solid duralumin push rods with steel ball ends. The valves function in phosphor bronze guides with a nickel-chrome seat for the inlet valve and a Monel metal seat for the exhaust valve. All of the valve rocker mechanism is enclosed with the cylinder head forming one-half of the valve rocker arm box and an Elektron cover plate completing the enclosure. Each valve rocker arm has a cupped end containing a hardened steel ball with a flat which contacts the end of the valve stem. The ball is free to rotate in its housing so that it presents a large wearing surface. Valve clearance is maintained by making the ball cup adjustable.

Carburation is provided by a Claudel-Hobson Al-48G downdraft carburetor equipped with an independent altitude control. Gasoline is fed to the carburetor by an Amal duplex pump fitted

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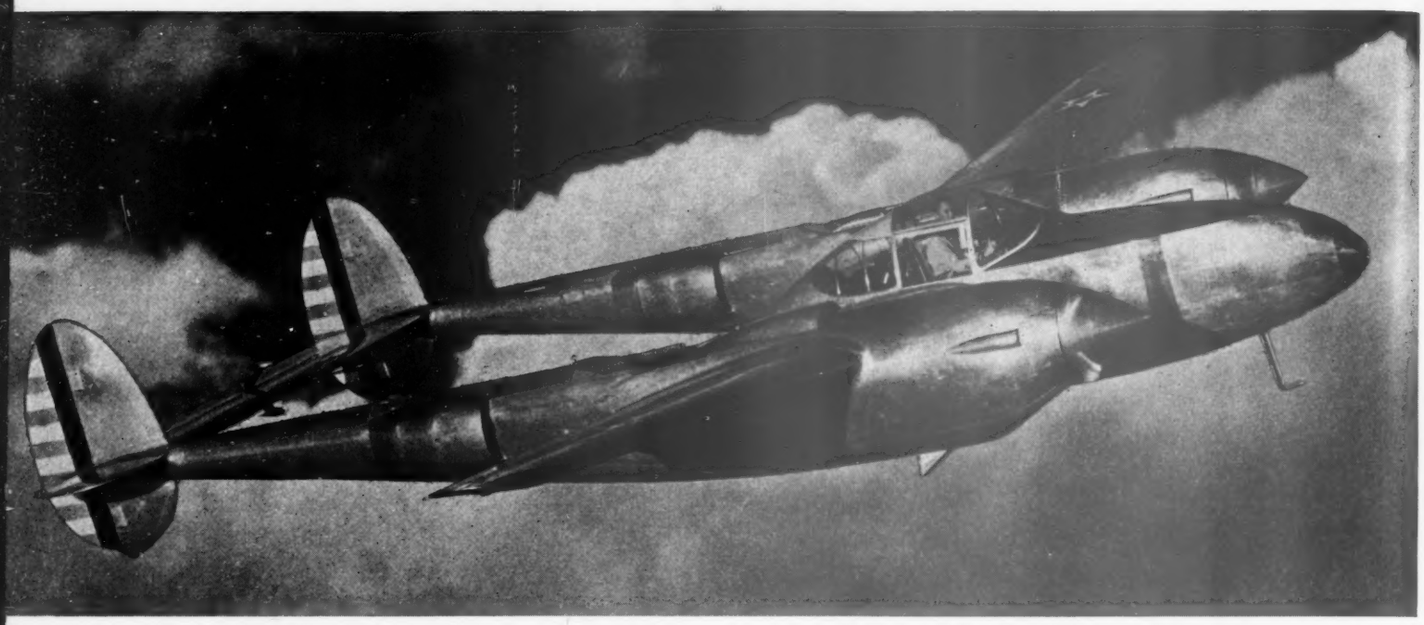


THE P-38 INTERCEPTOR

ONE of the most interesting airplanes being produced in the United States today is the Lockheed P-38. From both a design angle, and because of its potential military value to U.S. and Great Britain, this ship is being watched with great interest.

Top speed, according to reports from England, is 404 m.p.h. at 16,000 ft. Range is 600 miles with the ship cruising at 350 m.p.h. Service ceiling is 30,000 ft. Wing span is 52 ft.; length is 37 ft., 10 in.; wing area is 327 sq.ft. Weight empty is 11,171 lb., and gross weight is 13,500 lb.

The interceptor pursuit is a distinctly recent type of combat plane. Only in the past few years have bombers been fast enough and able to fly at sufficiently high altitudes so that a defending force needed a fighter craft able to get off the ground in a great hurry and have climbing ability great enough to intercept bombers before their objective was reached.

In its P-38, Lockheed has one of the fastest climbing fighter ships now in service. Its two Allison engines will climb it at the rate of 2,860 ft. per min. And when it has bored its way up into the high altitude to meet the oncoming bombers, it has plenty of firepower to be effective. On the prototype ship ordered by the British there was a cannon in the nose and four machine guns in the wings. Rumor has it that the British are putting in an additional cannon, and that it is being built for them as a two-seater with a gun turret. Information on the equipment for U.S. planes is restricted.

The first production model came off Lockheed's assembly floor recently. This is one of the ships for which real production orders have been placed by our Air Corps and England, also, has ordered it in quantities. The British order is reported to be nearly 1,000.

This type of airplane has not only presented new problems to the design engineer but it is offering new obstacles to the pilots who will fly it. In most pursuit ships the climbing speed is gradual enough so that the pilot gets accustomed to the thin air as he reaches high altitudes. The P-38 climbs so rapidly that, in the case of Lockheed's test pilot at least, it was thought wise to "supercharge" him.

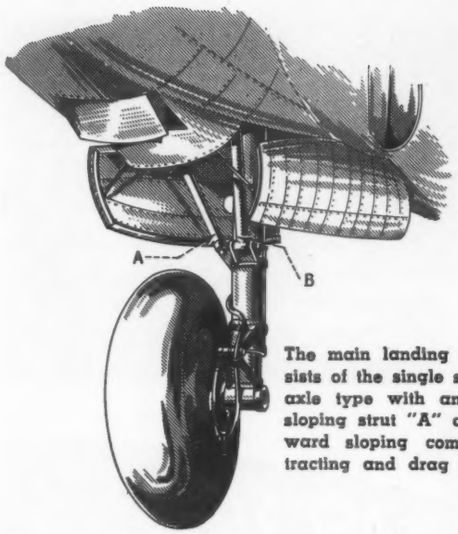
To prepare for his test flights, Milo Burcham of Lockheed inhaled pure oxygen for 30 min. while he was taking exercise. The combination of oxygen and exercise eliminated approximately 50 percent of the nitrogen in his system. It is the nitrogen that expands to form bubbles in a pilot's tissues and blood stream if he reaches great altitudes too rapidly. This condition is known as the "bends."

On the advice of the Mayo Clinic, Lockheed built a decompression room next to its test hangar at Union Air Terminal, Burbank. In the room was a bicycle exercising machine, oxygen cylinders, inhalation apparatus, oxygen fittings and flasks. Burcham donned the inhalation apparatus, which consists of a nasal face mask, a breathing bag and a rubber tube connected with an oxygen cylinder. Then he turned on the oxygen and began to pedal the bicycle. By the time he had ridden for 30 min. he was ready for the flight. Still inhaling only oxygen, he walked to the plane, climbed in, and made his flight. He did not breathe any "fresh air" until his flight was over.

Some flight surgeons believe that combat pilots awaiting a call to fly interceptors to high altitudes may have to spend a half hour in a ready-room where they will breathe pure oxygen. This would prevent them from getting the "bends" during combat fighting at high altitudes.

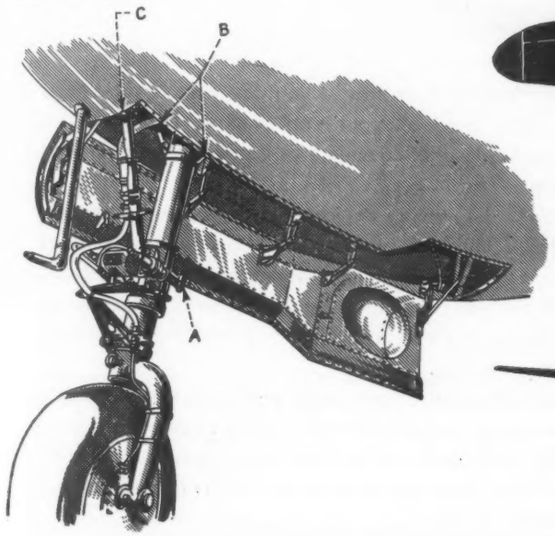
Marshall Headle, Lockheed's veteran chief test pilot, recently said: "Very little good is accomplished in developing planes capable of high speeds in the stratosphere if the pilots are not in condition to utilize that speed and performance. Reactions are always slower at high altitudes, even with an adequate supply of oxygen, and speeds are greater. Any further handicap could easily render the pilots virtually useless and jeopardize their safety."

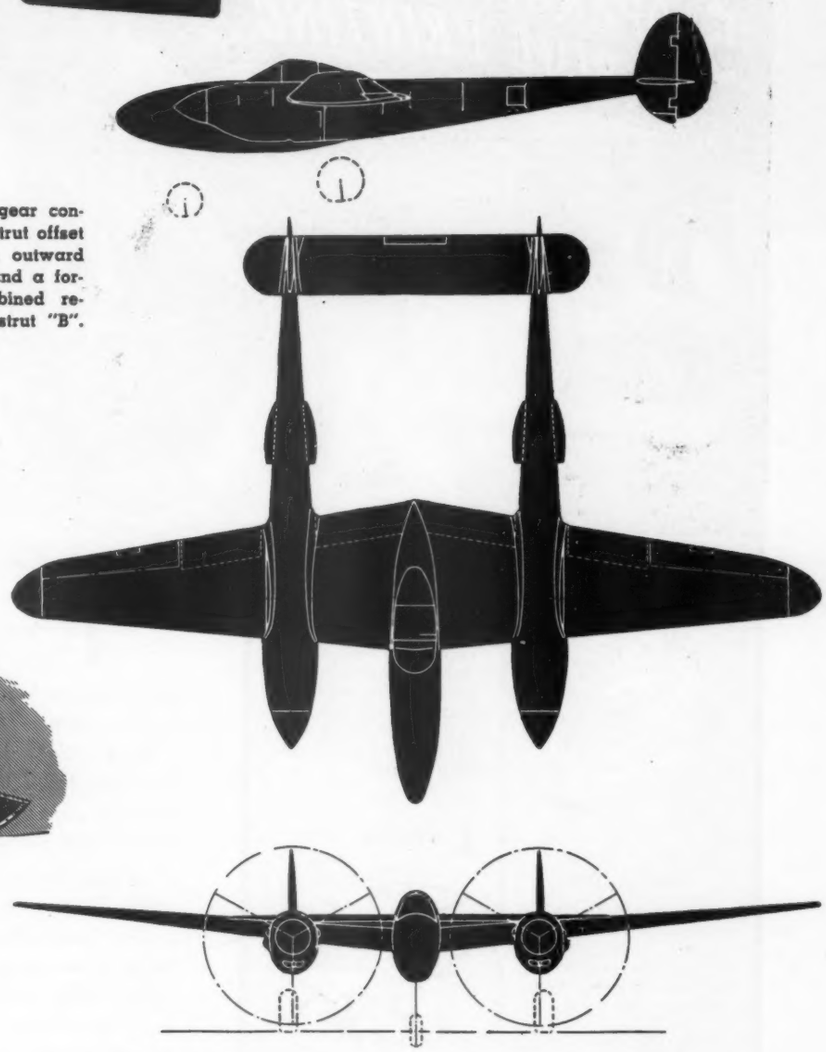
Flying EQUIPMENT

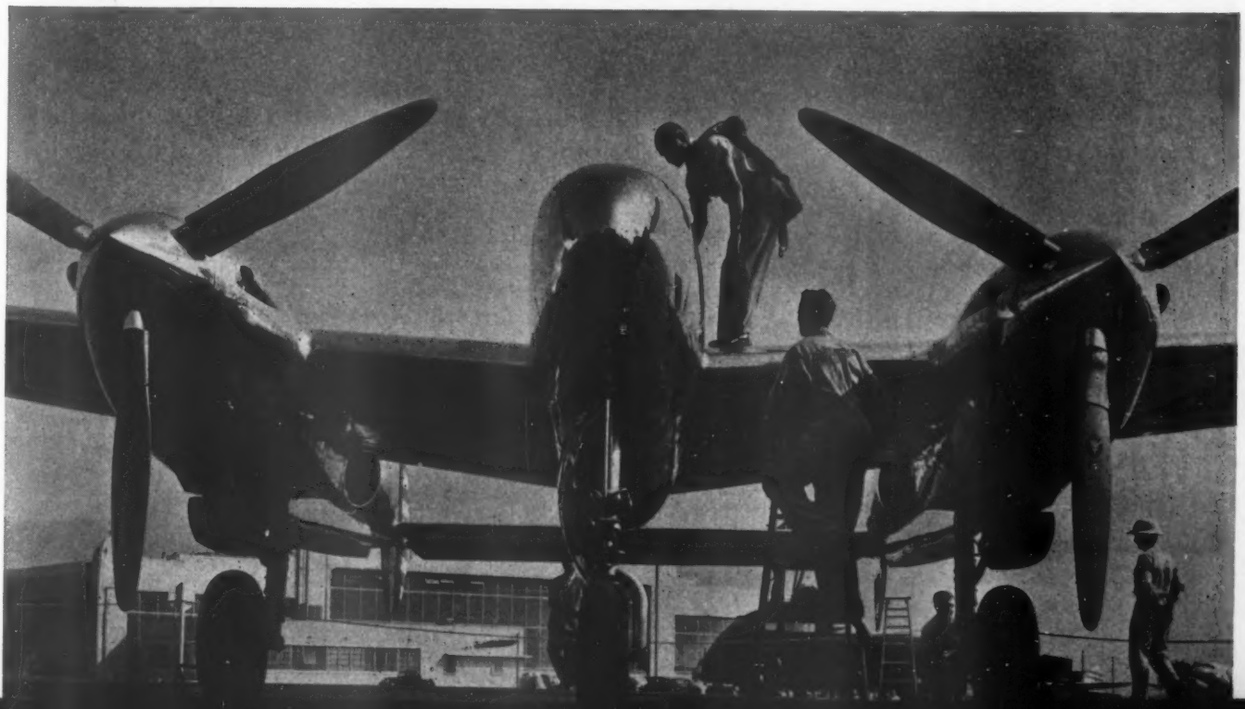


The main landing gear consists of the single strut offset axle type with an outward sloping strut "A" and a forward sloping combined retracting and drag strut "B".

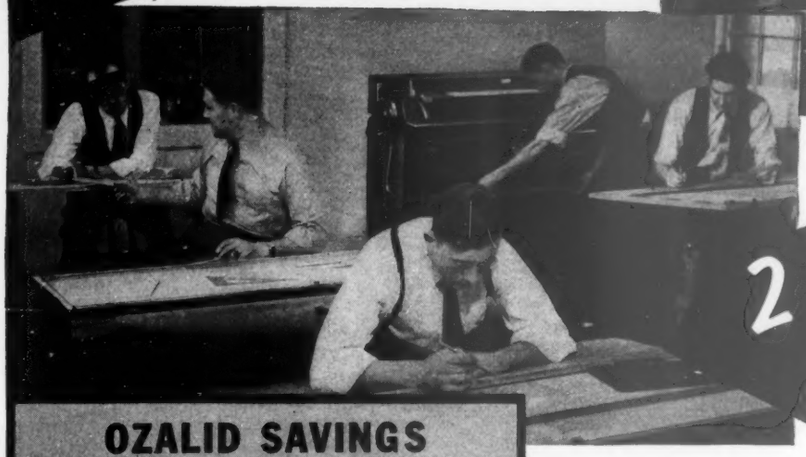
The nose wheel can travel sufficiently to turn the plane but is restrained by a fluid shimmy dampening device "A". "B" is a pair of symmetrical side brace struts and "C" is forward sloping combined retracting and drag strut.





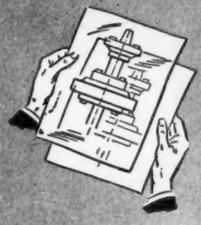


5 OPERATIONS WITH BLUE PRINTING...



2 EASY STEPS WITH OZALID

OZALID SAVINGS



SAVES DRAFTING

Duplicates of originals on transparent paper, cloth or foil for branches or customers are produced in the same simple manner as standard Ozalid Whiteprints.

SAVES TIME

Ozalid Whiteprints are made in two simple operations...(1) exposure and (2) dry development... without washing, fixing, drying or trimming.

1 EXPOSURE

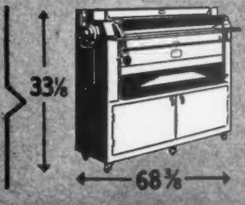
2 DRY DEVELOPMENT

SAVES LABOR AND MATERIALS

In all except the fastest Ozalid Whiteprint machines one operator handles capacity production. Ozalid cut sheets avoids trimming which saves up to one-third in materials.

SAVES SPACE

All Ozalid machines are compact in design and can be installed in any plant, office or drafting room. The Model "F" as illustrated occupies less than 16 sq. ft. of space.



IN rigging your production for an all-out effort, don't overlook your print making equipment. A back number in the print room is a veritable jinx to high-gear performance.

When your print making equipment becomes a bottleneck, it breaks down the co-ordinated steps of production...stands men up . . . ties a knot in your entire operating schedule. Don't wait till your reproduction department bogs down. Your guarantee of a fast, even flow of prints is the adoption of the Ozalid Process.

The Ozalid Process reduces print making to the two simple steps of exposure and dry development . . . completely eliminates three operations in the old-time blue print process and, in addition, provides positive prints, developed dry and true-to-scale.

For prints on the spot . . . in a hurry . . . when you want them, choose the Ozalid Process. There is a full line of Ozalid Whiteprint Machines which do a complete job of print making . . . and for those who already have blue printing equipment which can be used as a printer, there is a selection of dry developing machines.

Send today for illustrated literature on the Ozalid Process and equipment. Free sample booklet of dry developed Ozalid prints on request.

SPECIFY *Ozalid* WHITEPRINTS

OZALID PRODUCTS DIVISION

GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, N. Y.

Ozalid in Canada • HUGHES OWENS CO. LTD., Montreal

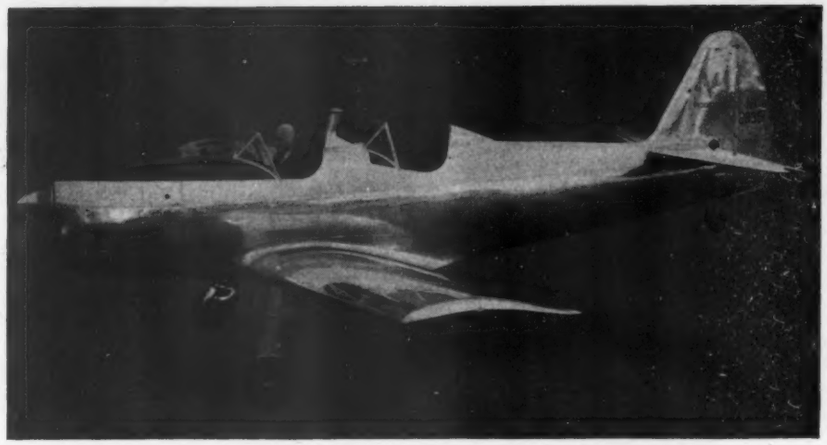
Flying EQUIPMENT

The VEGA 35

A New Primary-Secondary Trainer

By B. A. Martin, Jr.

Chief Test Pilot, Vega Airplane Co.



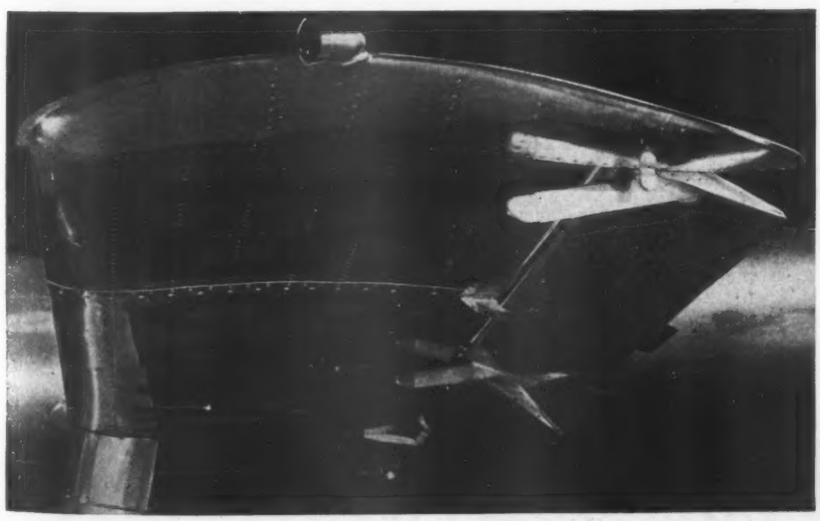
NOW in production by the Vega Airplane Co., the Vega 35 is an all-metal, low-wing, primary-secondary trainer with the clean lines of a racing plane. The full cantilever wing carries no exterior bracing. The moncoque fuselage and the cantilever tail members are faired together for improved streamlining.

In the air the Vega 35 handles easily and is responsive to the controls. I have flown both the prototype and the first of the production models, Serial No. 101, almost continuously during recent months and have put them through every possible maneuver. They have a feeling of ruggedness that I have never before experienced in commercial planes, and this is confirmed by other pilots who have flown them. Even under the highest load conditions I have yet to note any deflection of the wings.

In spite of its ruggedness, the Vega 35 is a small plane. Its wing span is 29 ft. 8⅞ in., and over-all length is 25 ft. 5¾ in. Gross weight is 1,891 lb. Features not usually found in small aircraft are incorporated, such as all-metal construction, stainless steel firewall, steerable tail wheel, turn-over truss integral with fuselage structure, monocoque engine mount with quick-removable engine cowling, and full cantilever landing gear. A distinguishing feature is the use of "square" wing tips with decided lower surface camber.

Original design of the Vega 35 was purchased from North American Aviation Corp., together with manufacturing rights. Vega engineers have made numerous changes of a more or less detailed nature to further improve the excellent flying qualities of the plane and to facilitate manufacture on a mass production scale. The plane is designated a primary-secondary trainer because it is applicable as a primary trainer for service pilots, and a secondary trainer for advanced Civilian Pilot Training Program students.

Novice flyers will like the plane's responsiveness on the ground and in the air, its directional stability, and ease of landing with flaps up or down. Excellent visibility is provided from either cockpit.



A look underneath the wing reveals the aileron and flap control mechanism, using a mechanically balanced system for the aileron.

Normal tendency of an airplane in a stall is to fall off on one wing and slip into a spin. Vega engineers have sought to reduce this tendency by improving the stall characteristics. When the Vega 35 stalls its nose drops straight forward without rolling. In addition, the pilot is given warning of the approaching stall by a slight but unmistakable buffeting of the tail group. Contributing to the unusual stall characteristics of the plane is the wing design, the undersurface of which, near the tip, has been given a concave camber. Usually a stall starts at the wing tip and results in loss of control of the ailerons. Even in a stall the pilot of the Vega 35 still has aileron control. This is a real asset in a training plane.

Trailing edge flaps are provided on the "35" in order that students may gain the feel of flying a "flapped" airplane. Due to the effective use being made of flaps in the new service planes this is an important feature.

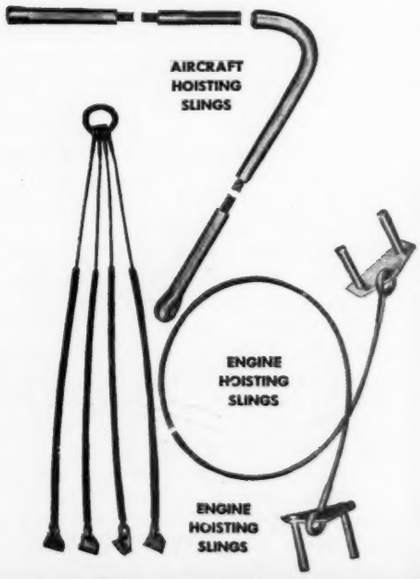
The fine directional control characteristics of the Model 35 make its entry into and recovery from all snap stunts very satisfactory. Spinning characteristics are also good, as the plane will recover from a six-turn spin, either direction, in from 1 to 1¼ turns after the controls are released.

Engineered to carry power plants ranging from 125 to 180 hp., the Model 35 has a maximum speed of 124 m.p.h. at sea level when fitted with the Menasco D-4 engine of 125 hp. Cruising speed is 112 m.p.h., landing speed 48 m.p.h., rate of climb 725 ft. per min., service ceiling 12,500 ft., and range at 75 percent of power, 312 miles.

Designed to give dependable and economical service, all well as for rapid production, the "35" has a sparless type cantilever wing in which all loads are carried by the skin, properly supported by lateral stiffeners and internal ribs.

Cockpits are fitted with duplicate sets of flight and engine controls, instruments and toe-operated brakes, adjustable parachute-type seats, seat-back cushions and head rests.

American Cable "Korōdless" AIRCRAFT CONTROL EQUIPMENT



● Sharply increased production of our full line of aircraft controls and accessories has in no way affected the painstaking precision manufacture that has always characterized American Cable products. In many ways our control equipment *exceeds* Army and Navy specifications. We have been, and always will be "In Business for Your Safety."

American Cable control assemblies are available in galvanized, tinned or "KORŌDLESS" stainless steel. The strand and cable, being preformed, have exceptionally high resistance to bending fatigue. They can long endure the torture of small diameter sheaves and so last the life of the plane. They can be fitted with the "TRU-LOC" end attachments, either standard or especially designed. TRU-LOC terminals are compact, reduce weight and eliminate the stretch found in thimble splices. They are the most efficient cable terminals made.

Specify American Cable controls and fittings for assured dependability. Write for literature and prices.

AMERICAN CABLE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
WILKES-BARRE, PENNSYLVANIA
Aircraft Department: 230 Park Avenue, New York City; General Motors Bldg., Detroit; 2475 Porter St., Los Angeles

AMERICAN CABLE "Korōdless" AIRCRAFT CONTROLS

	Guarantees (Estimated)	Performances (Actual test results)
Maximum speed at 16,400 ft.		
Military rating	228 m.p.h.	260 m.p.h.
Normal power	224 m.p.h.	
Cruising speed at 16,400 ft.		
65% normal power	184 m.p.h.	215 m.p.h.
Landing speed at sea level	72 m.p.h.	65 m.p.h.
Take-off to clear obstacle of 50 ft. at sea level	2,100 ft.	Cleared 75 ft. from 2,100 ft. run starting from lake surface 1,500 ft. above sea level.
Service ceiling	24,000 ft.	29,000 ft.

N-3PB Patrol Bomber

WITH DELIVERY in February of the first Northrop N-3PB patrol bomber seaplane, Northrop Aircraft, Inc., set a unique production record by designing, tooling, building, testing, and delivering a military airplane in just eight months. This record was established in spite of the fact that Northrop Aircraft did not even have a factory building completed when the order was taken.

A three-place single-engine, low-wing full cantilever monoplane seaplane equipped with two Edo floats, the N-3 patrol bomber incorporates novel features of design and construction. In addition to a load of 2,000 lb. of bombs, each plane is equipped with six machine guns. Four .50 caliber guns are mounted in the wings, and two .30 caliber guns on flexible mounts are carried in the fuselage to fire aft, top and bottom.

Of general design and construction made familiar by earlier Northrop planes, the N-3 incorporates stressed skin aluminum alloy covering over fuselage, wings, and fixed tail members. The fuselage is fabricated in two sections, divided along the horizontal centerline, the lower half being built integral with the center wing section. Generous use of extruded aluminum alloy stringers is made in fuselage and wings. Accommodations for the crew are provided in tandem cockpits, with a transparent enclosure of streamlined form extending over the three cockpits. As in earlier Northrop designs, the split trailing edge wing flap is incorporated. Power is supplied by a Wright Cyclone GR-1820-G200 engine of 1,200 hp.

The two Edo floats are mounted to the center wing section by streamlined full cantilever pedestals, eliminating all struts and brace wires. The airplane may also be equipped with wheel landing gear for operation from land.

A measure of the excellence of this airplane is given by comparison of test results with the performances originally guaranteed to the Norwegian gov't:

Specifications and performance data on the Cyclone powered N-3PB are:

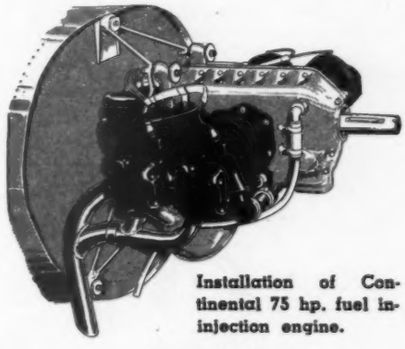
Wing span	48 ft. 11 in.
Overall length	38 ft.
Overall height	12 ft.
Wing area	376.8 sq.ft.
Wing loading	24.4 lb./sq.ft.
Power loading	7.65 lb./hp.
Gross weight	10,600 lb.
Fuel capacity	320 gal.
Oil capacity	23 gal.
Maximum speed	260 m.p.h.
Cruising speed	215 m.p.h.
Service ceiling	28,400 ft.
Cruising range	1,400 miles

The Silvaire Seaplane

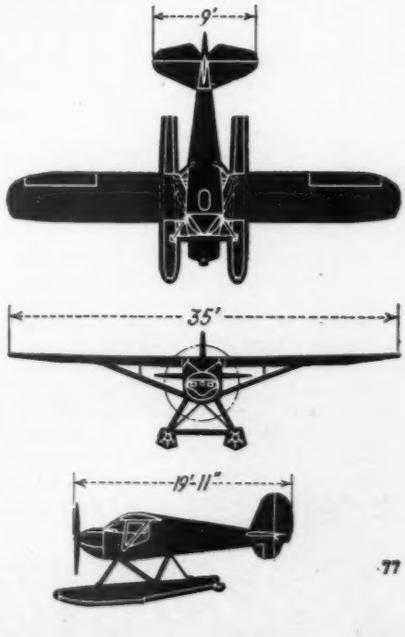
RECENT APPROVAL for their Silvaire light plane to be used as a seaplane has been given to the Luscombe Airplane Corp. of West Trenton, N. J. Powered by a Continental 75 hp. engine it is equipped with No. 1320 Edo pontoons and has a gross weight of 1,260 lb. Take-off from calm water, no wind, is possible in 12 seconds under full load conditions, and rate of climb is 650 ft. per min. Weight empty is 772 lb. while useful load is 488 lb. Cruising speed is 102 miles per hour with a design flight speed of 115. Landing speed is only 40 miles per hour. Service ceiling is estimated at 12,500 ft. These figures represent an increase in performance over the Standard 8A seaplane introduced 18 months ago.

The new Silvaire seaplane is identical to the landplane but includes in addition complete corrosion proofing, anodizing, metalizing and insulating treatments to protect it from any trace of corrosion during service. Dural parts are treated and heavily primed, steel parts are metalized and dissimilar metals are insulated against galvanic action. An Alclad covered sub-fin is bolted on in place of the usual tailspring. The Silvaire seaplane is readily changed over to a landplane, and brake pedals can be furnished for this purpose at slight extra cost when desired.

Standard equipment includes cowling grills, fuel injection, Continental 75 hp. dual ignition engine, ash trays, glove compartments, compass, shock mounted instrument panel and other items. Extra 4½ gal. wing tanks are available on special order increasing the 325-mile range to 525 miles.



Installation of Continental 75 hp. fuel injection engine.



Flying EQUIPMENT

The Birdmen's Perch

Editing this page, is one series of surprises after another. I'd just about given up on getting any more stories about boners while flying. And then all of a sudden the customers seem to lose their bashfulness and I get dozens of 'em! You'll find this month's choice printed below.

Major Al Williams, alias "Tattered Wing-Tips,"
Gulf Aviation Products, Gulf Building, Pittsburgh, Pa.

FUNNYBONER DEPT.

Last summer I had to make a rush trip to Salt Lake City. Upon approaching the field, the red light in the tower showed closed so I circled until the approaching air liner came in. By this time I was well away from the field and anxious to get down, so I peeked back over my shoulder to see if the clear lights would flash. But because of the position of the ship it was impossible to see, so did I turn the ship or slip it? I did not. I poked my old bald head out of the window and Zing! went a $22.00 pair of glasses. Why can't a person learn things more easily?

J. P. INNES,
Ogden, Utah.

Mr. Innes, you have our sympathies. We've yet to meet an airman who got his experience free of charge.

HOW TO GO WACKY DEPT.

The juggling act printed below is from Mr. Carol Henry of Rapid City, S.D. Do your worst, fellows. *We* know the answer.

A pilot made a forced landing on the South Dakota plains. He had in the baggage compartment two drums of Gulf Aviation Gasoline. The first drum was too heavy so he poured 12 gallons into the second drum. The first drum then contained 6/11 of the amount in the second drum. If he had poured 16 gallons back into the first drum, the second would have contained 7/10 of the amount in the first. How many gallons of G.A.G. did each drum contain?

IT DOESN'T LOOK UNUSUAL . . . BUT IT IS!

We received a mighty nice letter from one of our readers the other day, expressing his appreciation of the many things Gulf goes out of its way to do for airmen. We really appreciated his sentiments, but we'd like to remind you, and him, that one of the *finest* things Gulf does isn't quite so apparent.

That's the extra trouble we go to in refining Gulfpride Oil. Besides regular refining processes, we put it through an extra process that removes up to 20% more of the carbon-and-sludge formers. This doesn't show up in the *looks* of the oil, but it does show up in the way it stays "up" in your motor and pares engine wear and repair bills.

THIS MONTH'S WHOPPER

Dear Major:

I am, along with 6,340 more boys, very grateful to the makers of that good old Gulf Aviation gas, for the splendid way in which they have pushed education ahead here at Texas A & M. Yes, it has really rushed things up for us, or at least it did for a couple of days. It isn't too long a story so here goes:

About the 20th of December, last year, the college airport manager had his underground tanks filled with G.A.G. By the 3rd of January, the tanks were empty and the dealer was called out to refill them. Unfortunately (or should I say "fortunately") the dealer was out of town and sent his helper. The boy had put in only three gallons when he decided he wanted to light his pipe, which he promptly did. Well, it's the same old story of the lighted match. It landed right in the middle of the gasoline! The tank, boy, and three gallons went sky high!

The surprised but unhurt lad landed close to Dallas in some farmer's silo; the tank was found near San Antonio; but the G.A.G. formed a cloud above the campus!

The next day the weather turned off bad and the ceiling became absolute zero. The cloud of G.A.G. settled upon the campus like bees upon the comb. Night came. Everyone opened their windows to let in the wonderful fresh night air. By the next morning, everything and everyone was thoroughly saturated with a dilute solution of that powerful G.A.G.! BELIEVE IT OR NOT! WHAT LITTLE G.A.G. WE HAD BREATHED WAS POWERFUL ENOUGH TO GIVE US THE ENERGY AND SPEED TO FINISH A WHOLE MONTH'S SCHOOL WORK, TAKE THE FINAL EXAMS, AND REGISTER FOR THE NEXT SEMESTER, *ALL IN THE SPACE OF 48 HOURS!*

Thank goodness, you didn't make it a mite more powerful because an hour later the effect had worn off! Naturally, we had the rest of the semester off, thanks to Gulf's great contribution to the aviation world! This is why 6,340 Texas Aggies appreciate your famous product now, if they didn't before!

By the way, the boy is now SHINING SHOES FOR A LIVING!!

Sincerely yours,
JOHN M. HOLMAN
alias "Shattered Rudderbar"

Gulf Oil Corporation and Gulf Refining Company . . . makers of

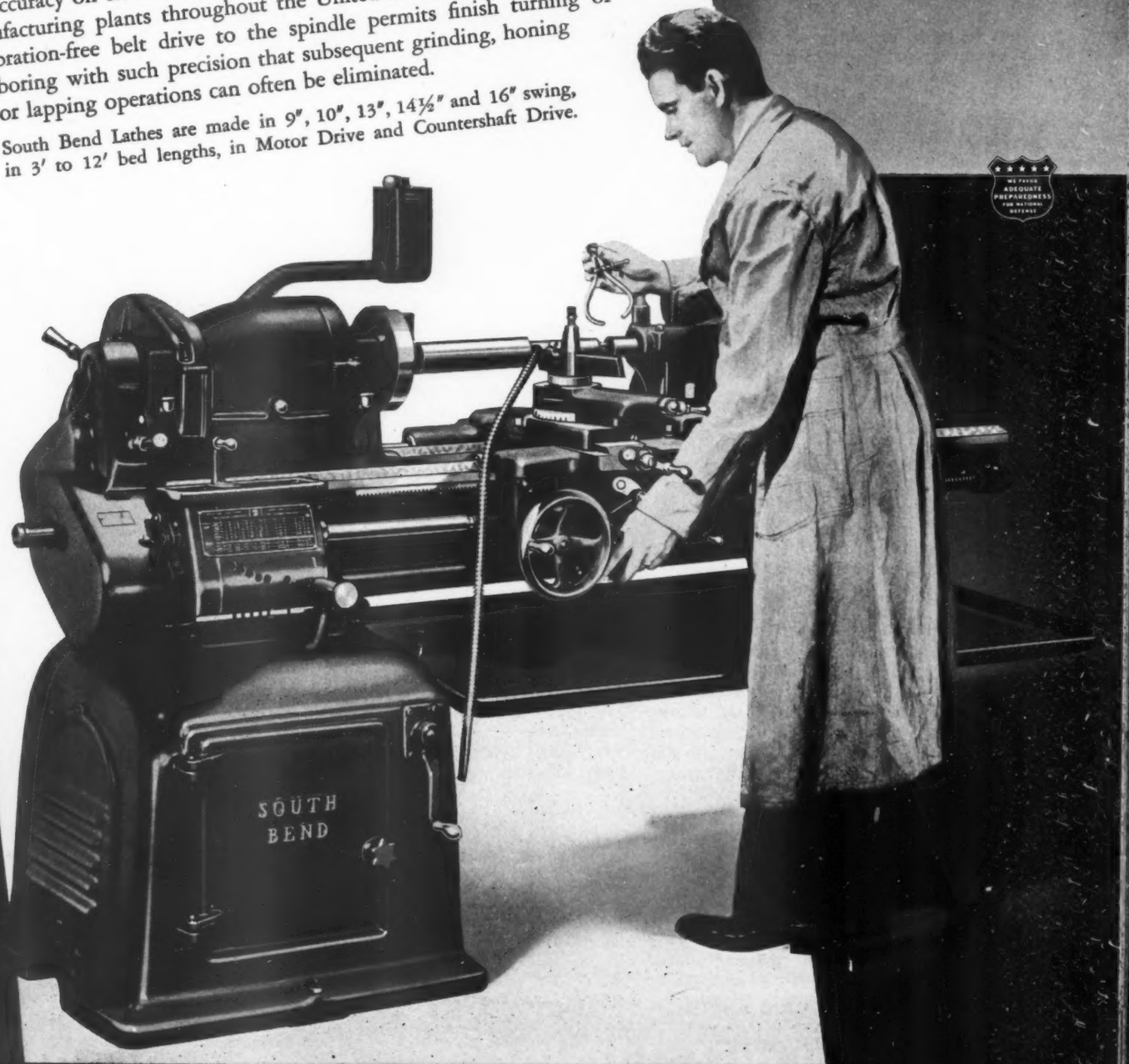
GULF **GULF AVIATION PRODUCTS**

THE *Precision* REQUIRED FOR MODERN INDUSTRY

South Bend Lathes are designed and built to provide the extreme precision required in modern industry. They are giving tool room accuracy on close-tolerance production work in hundreds of manufacturing plants throughout the United States. The smooth, vibration-free belt drive to the spindle permits finish turning or boring with such precision that subsequent grinding, honing or lapping operations can often be eliminated.

South Bend Lathes are made in 9″, 10″, 13″, 14½″ and 16″ swing, in 3′ to 12′ bed lengths, in Motor Drive and Countershaft Drive.

SOUTH BEND LATHES



SOUTH BEND LATHE WORKS

LATHE BUILDERS SINCE 1906

755 E. Madison St., South Bend, Ind., U.S.A.

Aviation's Perspective Position

By Selig Altschul

THE season of annual reports is at hand. More complete and detailed than ever before, these yearly accounts of stewardship seemingly take the stockholder by the hand and retrace the devious path followed the previous year. Probably the most interesting corporate reports are those released by the aviation industry. A year of record-breaking accomplishments, a wide sprinkling of astronomical figures, together with colorful charts and graphs are among the characteristics that feature the current crop of annual reports in the aviation group.

The life of aviation companies, however, as related by these annual accounts is not all percentages and ratios. Underneath these figures, a pertinent trend is discernible and often provides a clue as to the future.

Taken by itself the air transport group shows another year of progress and new highs in virtually every department. Compared with other industries, however, the air carriers still represent a picayune enterprise. Total revenues for 1940, while up about 38 percent from the previous year, aggregated only about $75,000,000. Compare that amount with the sales of any one single corporation of national importance.

Passenger revenues established the best gains with an estimated total of about $54,000,000 up 54 percent from 1939. It is interesting to note that all Class I Railroads recorded total passenger revenues of $417,269,000 for 1940, an increase of only 0.1 percent over the previous year.

The significant feature of these comparisons is this: while railroad passenger revenues far surpass those of the air carriers, the trend is definitely in favor of the air transport group. And in markets and horse races it is the trend that counts. More strictly comparable are the figures of the Pullman Co. whose business is more closely competitive with that of the air lines. This railroad agency suffered a decline in its gross revenues from $60,676,000 in 1939 to $59,877,000 for 1940.

It is reasonable to believe that 1941 will see the air transport's domestic passenger revenues pass those of Pullman by a safe margin.

Another interesting comparison is found in the case of leading railroad carriers. Not so many years ago, any number of individual railroad companies was far ahead in passenger revenues as contrasted to the nearest air line competitor. Today this is no longer true. For example, in 1940 American Airlines with passenger revenues of $15,899,000 was surpassed in this department by only five railroads. (In 1938, 13 Class I railroads exceeded American in volume of passenger business). And note the 1940 passenger revenues of the railroads which currently surpass American: Pennsylvania, $71,623,000; New York Central, $59,322,000; Southern Pacific, $24,480,000; Santa Fe, $18,493,000; and Union Pacific, $17,472,731. Interestingly enough, the present trend would indicate that American, within a few years, could overtake all of these railroads in passenger revenues with the exception of the Pennsylvania and New York Central which would take a much longer hike.

So much for the broad perspective as it relates to the air carriers. A number of trends within the industry, however, have also become evident. The ratio of mail revenues to total revenues was the smallest in history, estimated at about 26 percent. This is another indication of the lessening dependence upon government support in the form of mail payments.

Yet, while most of the carriers have obtained some form of relief through adjusted mail compensation, there appears a remarkable unanimity in the intention to petition further the CAB for more favorable mail rate decisions.

Greater recognition is also being given the subject of air express. One report simply states: "When it is economically and technically practical, such a program should be developed by the entire industry." Another company acknowledges ". . . the lack of reliable information about the possible market for such service, the rates at which goods can be moved in volume, and the type of equipment best adapted to such service." Contrary to outside belief, the industry is aware as to the potentialities of air express but recognizes existing practical limitations surrounding this operation. Nevertheless, express revenues continue to maintain consistent gains from year to year—1940 revenues from this activity aggregating more than $2,000,000, or a gain of about 24 percent over 1939.

Various air mail rate decisions have also resulted in adjusting earning statements as reported in previous years. For example, TWA's annual report for 1939 showed a deficit of $188,827. After reflecting retroactive mail compensation, as awarded in September, 1940, such loss was converted into a net profit of $107,133. However, final 1940 operations resulted in a net loss of $232,455. This loss was attributed to the extra expenses incidental to the inauguration of "Stratoliner" service, together with the negotiations attendant with the acquisition of the Marquette route and its operation. TWA, incidentally, was the only major line to have finished the year 1940 with a loss. Other carriers finishing the year with deficits were Braniff, Mid-Continent and Delta.

A mail decision also caused a major adjustment in the 1939 published report of United Air Lines. As adjusted, earnings for that year were increased to $776,534 or 52c. per share representing a material gain over the 21c. per share previously reported. United's 1940 final results showed a net income of $775,462 or 52c. per share—duplicating 1939's adjusted figure. The most startling feature in United's report, however, is the analysis that, excluding non-recurring income, the company suffered a loss in net operating income for 1940 as compared to 1939. Included in 1940 results was a total of $332,175 or about 22c. per share representing nonrecurring profits. This item resulted largely from the sale of the entire capital stock of United Airports of California to Lockheed Aircraft Corp. at a book profit of $255,690. However, even this transaction was not all pure profit, as United Air Lines had previously written off

(*Turn to page* 128)

Average Earnings Credits Per Share Leading Aircraft Companies

Company	*New formula*	*Old formula*	*1940 earnings*
Curtiss-Wright	$(a)4.50	$(a)2.55	n.a.
Douglas Aircraft	10.83	7.13	$18.05
Lockheed Aircraft	3.45	1.27	$3.16
Glenn L. Martin	3.75	2.02	3.92
No. Am. Aviation	1.93	.69	n.a.
Sperry Corp.	2.71	1.99	2.70E
United Aircraft	3.53	1.99	4.94

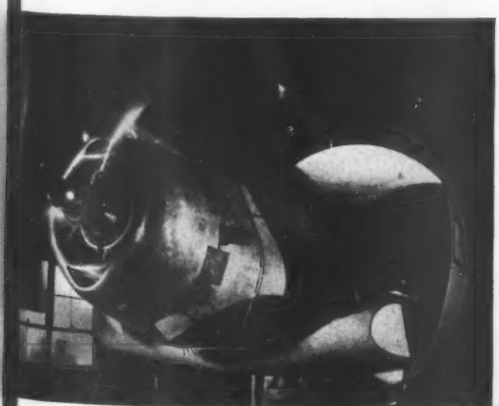
(E) Estimated. n.a. Not available. (a) On A stock.

Barron's Stock Averages

	Aircraft	*Air-Transport*	*50 Stocks*
Mar. 7, 1941....	36.22	21.56	71
Feb. 20, 1941....	36.00	21.53	71
Feb. 21, 1941....	33.88	20.33	70
Mar. 8, 1940....	46.15	25.91	87

WIDENING A "BOTTLENECK"

MAN MADE HURRICANE . . . this stationary 1000 h.p. motor drives a 4 bladed propeller at the end of Vultee's power tunnel to create wind blasts past the engine actually under test.



Engine being tested on a "mock-up" of actual engine mount, wing fuselage section of the model in which it will be used. At left is the test control room, where delicate instruments record performance under every flight condition

NEW VULTEE DEVELOPMENT

"Gets 'em into the Blue" – FASTER

TIME is the essence. "Get 'em into the Blue" for National Defense . . . *faster.* But plant expansion alone is not enough. Engineering methods must also be streamlined to hasten the flow of airplanes from the drawing board to final delivery.

Important in this is Vultee's new engine test tunnel . . . *first and only one of its kind in the United States* . . . in which actual flight conditions of a FULL SCALE engine installation are simulated, and performance proved in relation to a specific model, before the motor meets the airframe on the assembly line. *Months* of delay in getting into production are telescoped into *hours* by coordinated activity.

Streamlined engineering methods, high speed machinery and equipment, new manufacturing methods, *plus* expanded facilities,* are widening the bottleneck . . . will enable Vultee to multiply deliveries 10 times in '41 . . . into the Blue . . . off the production line . . . into the sky.

Stinson Aircraft, a division of Vultee, is now ready with its new commercial 90 H.P. "Stinson Voyager" . . . offering greatly increased performance. Write Stinson for complete information.

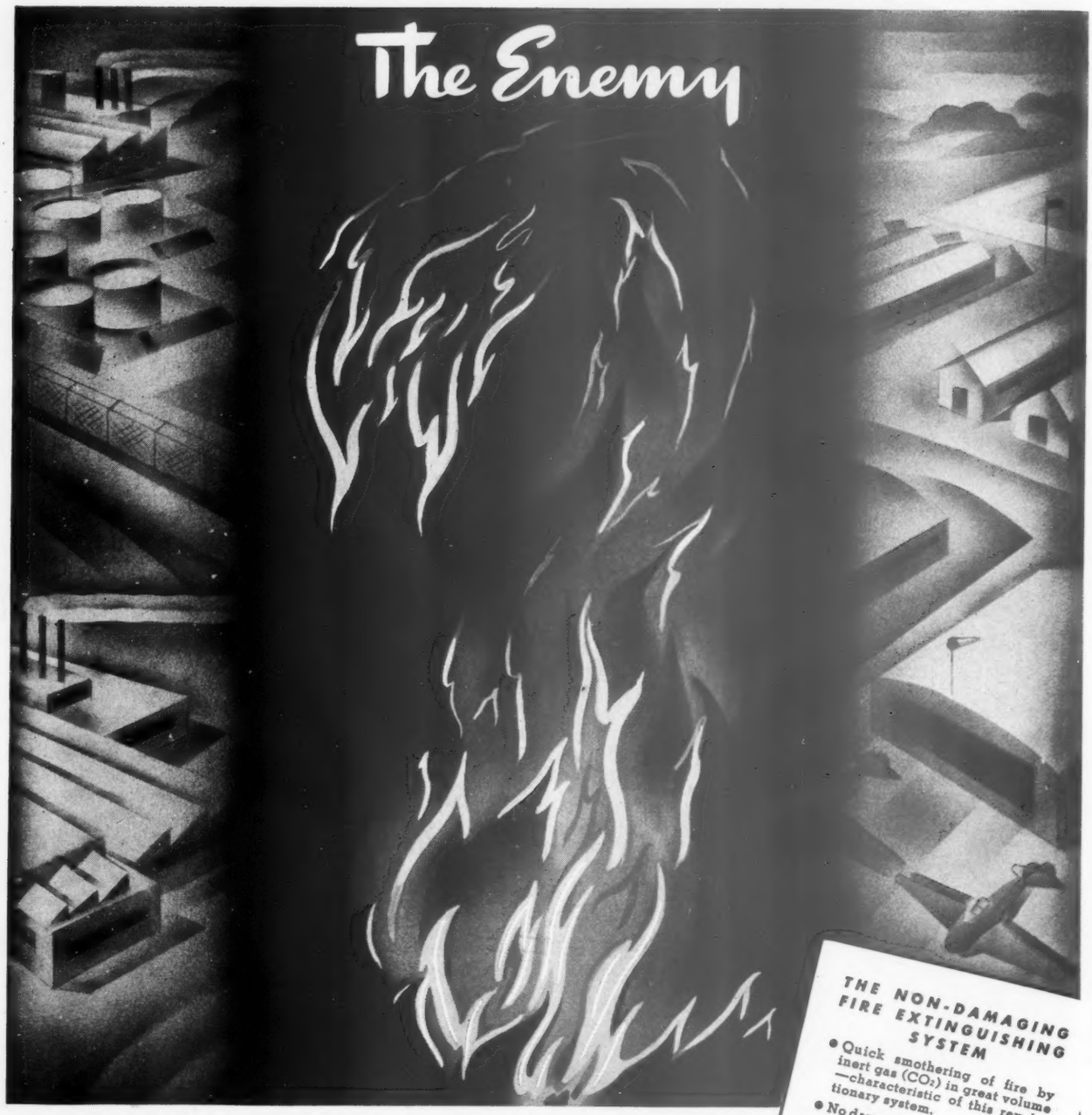
Early in 1941, Vultee becomes one of the first aircraft manufacturers to complete its current expansion program, representing an

Vultee Stinson

VULTEE AIRCRAFT, INC.

VULTEE FIELD, CALIFORNIA • NASHVILLE, TENNESSEE

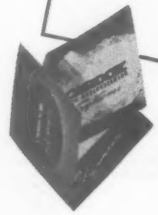
STINSON AIRCRAFT



The Remedy: CARDOX

THE NON-DAMAGING FIRE EXTINGUISHING SYSTEM

- Quick smothering of fire by inert gas (CO_2) in great volume —characteristic of this revolutionary system.
- No damage from the extinguishing medium.
- Very high rate of discharge up to many tons per minute.
- Adequate storage capacity for CO_2 in centralized tank releasing through any branch of the system (or combination of branches).
- Simplified piping installations.
- Any combination of manual or automatic controls suited to the hazard.

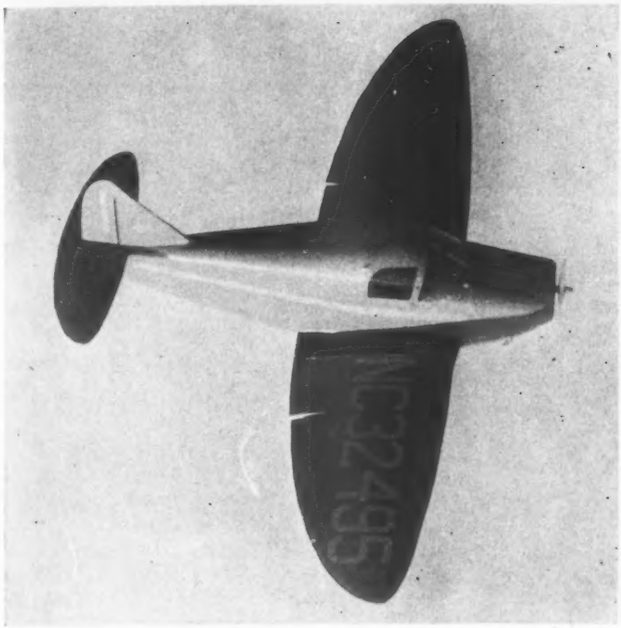


● A discarded match in the wrong place—through carelessness or treachery—could make a big dent in your plant's defense program. It is a natural step in meeting your schedules to take practical measures against such "bad luck"—especially when the first step is as simple as this—

Tell your secretary to drop us a line asking for the Cardox Data File explaining in full this simple way to overwhelm fire.

CARDOX CORPORATION · **Bell Building** · **Chicago**

The Cardox Data File includes a generally explanatory booklet and other literature on fields related to yours. Other bulletins are sent as available to keep your data up-to-the-minute.



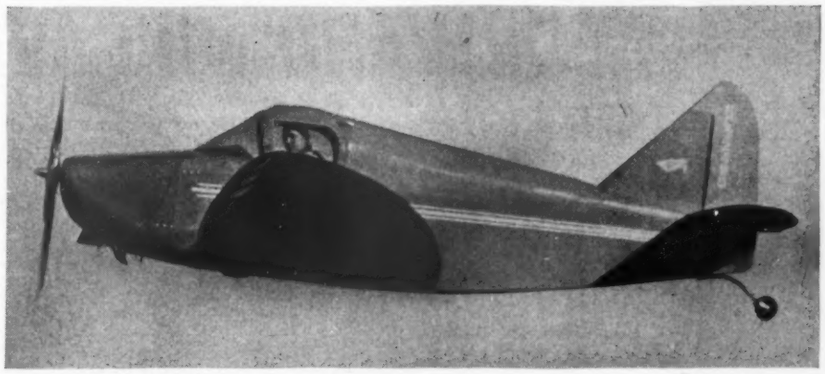
Franklin-Powered Culver

From the Culver Aircraft Corporation comes announcement of the new Model Cadet powered by an 80 hp. aircooled engine with added equipment and considerably improved operating performance.

Flying EQUIPMENT

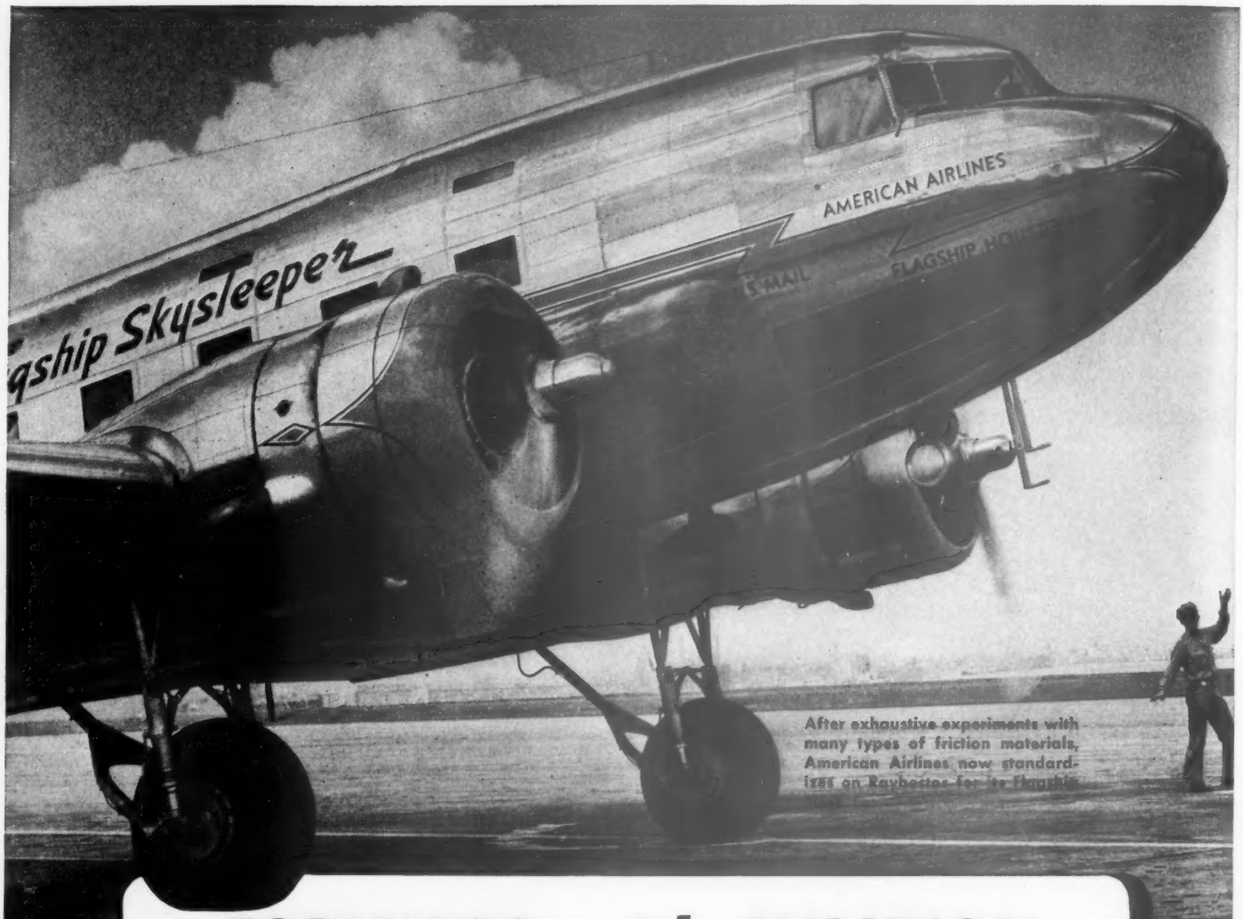
THE horsepower of the Culver Cadet, manufactured by the Culver Aircraft Corporation, Wichita, Kansas, has been increased from 75 hp. to the present 80 hp. Franklin aircooled engine. With this new addition several new pieces of equipment have been added including an electric starter, a motor driven generator, and a large 12-volt battery. This model, as in the previous model Cadet, has a retractable landing gear, is equipped with navigation lights, all of which have been included with standard equipment at no extra cost. In addition numerous changes have been made in the interior of the ship including a two-tone color scheme.

Specifications for the ship are: span 27 ft., overall length 17 ft. 8 in., overall height 5 ft. 6 in., landing-gear tread 79 in., and has a wing loading of 10.88 lb. per hp.



The photographs show the new Franklin installed in the Culver and the plane's clean lines when the landing gear is retracted.

The spars of the wings are of laminated spruce and the construction is wood ribs over which is fabric covering. The fuselage is of semi-monocoque construction, and uses a Culver Oleo spring landing gear shock absorber, and it also has a wheel tail unit. The retractable landing gear uses Hayes wheels size 500x4. The standard equipment includes an oil pressure gage, oil thermometer, air speed, altimeter, compass, ignition switch, fuel level gage, cabin heater and cabin vent, and position lights.



After exhaustive experiments with many types of friction materials, American Airlines now standardizes on Raybestos for its flagships

FORWARD with AVIATION

Just as Raybestos pioneered in the development of friction materials for the automobile, so today Raybestos is actively co-operating with the aviation industry in supplying specially engineered brake linings, clutch facings and frictional specialties of all types for every aeronautical purpose.

In addition, Raybestos offers plane and engine designers and manufacturers, and airline operators the services of the Raybestos Technical Department for consultation, research and development work.

We invite your inquiries about any frictional product or problem.

THE RAYBESTOS DIVISION *of Raybestos-Manhattan, Inc.,* **BRIDGEPORT, CONN.**

Raybestos

BRAKE LININGS, CLUTCH FACINGS *and* FRICTION MATERIALS *for every* AERONAUTICAL PURPOSE

Aviation—RADIO

Dialing the Air Waves with Don Fink

New Aircraft Line Announced

The trend toward the ultra high frequencies in aircraft communication, navigation and traffic control was advanced recently with the announcement by Air Associates, Bendix, N. J., of a complete new line of transmitters, receivers, and send-receive combinations for the frequencies above 40 Mc. The line consists of an aircraft receiver, UHR-140A, a matching transmitter, UHT-140A, and transmitter and a receiver for ground station use. Also available are an aircraft transmitter and ground station receiver for the intermediate frequencies in the 2.5 and 15 Mc ranges, as well as a transmitter-receiver for the light plane owner on the 3105 kc, 200-400 kc ranges. Finally a transmitter and receiver for owners of larger planes, for use on battery or generator power, are available.

The UHR-140A receiver is a two-channel affair, with provision for the use of six crystal-controlled frequencies, two in the range 140-144 Mc and four in the 129-131 Mc band. The receiver is a ten-tube superheterodyne, mounted in a "½ ATR" housing, complete with dynamotor power supply. The companion transmitter delivers approximately 30 watts, 100 percent modulated, on the same channels. Two similar housings are employed, one for the r-f circuits, the other the power and modulator circuits.

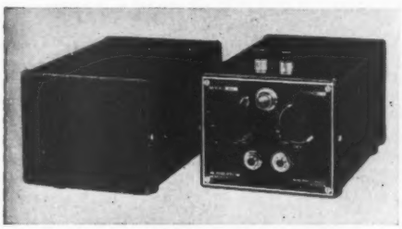
The ground station u-h-f receiver is essentially the same, except that it is equipped for relay-rack mounting, and covers the new 140-144 Mc band. It weighs 22 lb., is particularly designed for traffic control and airport communication generally. The ground station transmitter similarly designed for rack mounting has a power output of 50 watts.

The intermediate range transmitter, CT-3O, is similar in general specifications to the u-h-f airplane transmitter except that it is designed for the lower frequencies. It delivers 30 watts, fully modulated, on any of four frequencies in two channels. The companion receiver, CR-3G is a single frequency crystal-controlled rack-mounted job, with an efficient squelch circuit for eliminating noise during standby periods.

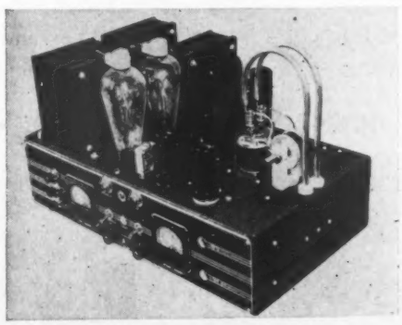
The transmitter-receiver for the light plane owner weighs 10½ lb. complete with dry batteries, headphones, microphone, cables and shock mountings. Only three controls are provided, receiver volume, receiver tuning, and a microphone push-button for controlling the transmitter. The transmitter power is 2½ watts on 3105 kc. The receiver, which covers the beacon band from 200-400 kc, has a reception range of from up to 200 miles, in average light-plane installations. Complete shielding of the receiver makes motor shielding unnecessary. A whip antenna, with loading unit for transmission, is used. Dimensions are 4½x3¾x7¾ in. Battery life is 100 hr. for reception, 7 to 8 hr. transmitting.

For owners of larger airplanes, equipped with a generator and storage battery system, the CT-2 aircraft transmitter and the CR-2 aircraft receiver are available. Both units operate from the plane's electrical system. Receiver covers the 200 to 400 kilocycle radio beacon and weather station band and the transmitter, with a power output of approximately eight watts, operates on any two frequencies falling within the 2,500 to 10,000 kilocycle channel. Both transmitter and receiver are designed for complete remote control operation.

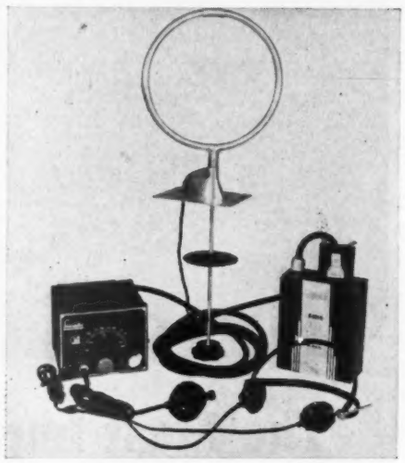
Air Associates also have available a complete line of accessories, interphone units, remote controls, shock mounts, whip antennas, automatic reel antennas, microphones, headphones, etc.



Air Associates airplane transmitter—receiver



Air Associates UHF ground station transmitter



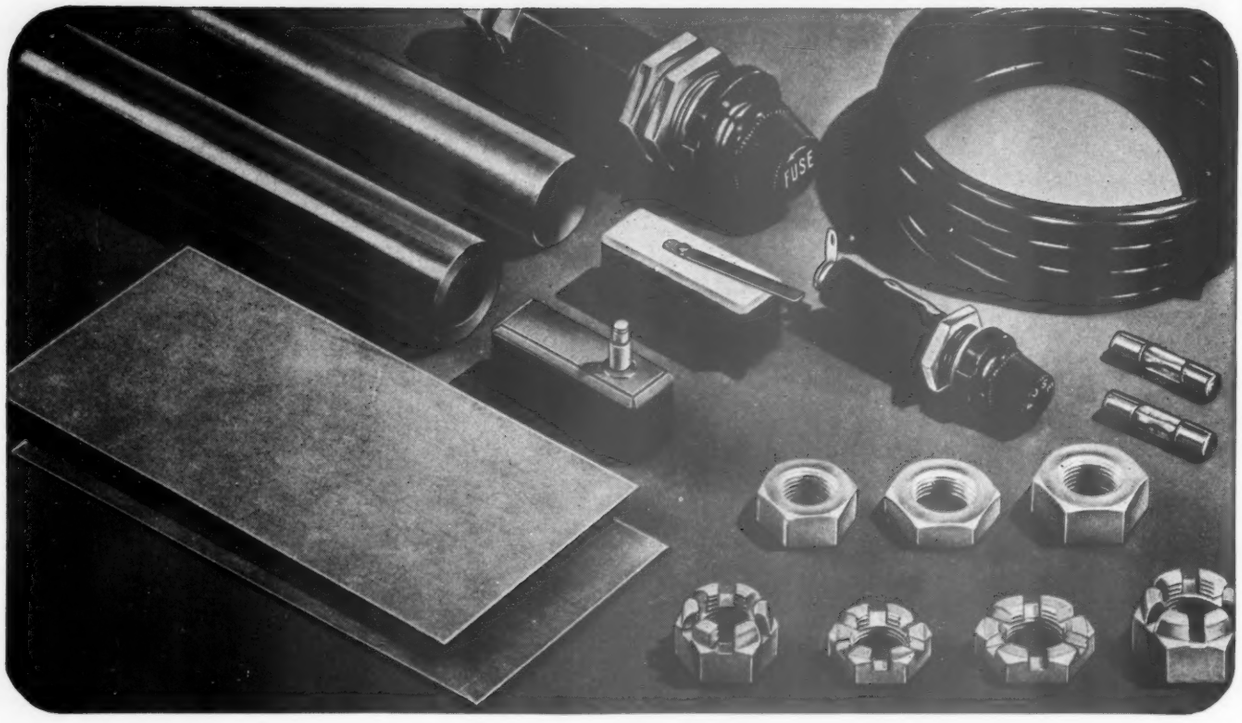
Learadio AMRL-1 dry cell receiver, direction finding loop and power pack

New Lear Receivers With Self-contained Interphones

The Lear Avia (Dayton, Ohio) receivers previously announced under numbers AMR-1, AMRL-1, AMR-12, and AMRL-12 are now available in re-designed form, with self-contained interphone circuits. The receivers are essentially the same in frequency range, 200-400 kc; sensitivity, 3 microvolts for 50 milliwatts output at 4-to-1 signal-to-noise; and selectivity, 3 db down 2 kc, 60 db down 12 kc. The AMRL-1 and AMRL-12, which may be used with directional loops with 50 microvolts per meter for 50 milliwatts output, are equipped with a loop tuning trimmer.

Airadio Equipment Racks

Airadio, Inc., of Stamford, Conn., has recently announced a series of stock item radio equipment racks, in all the standard ATR sizes. These racks make use of the new Cannon aircraft radio jacks, at the rear, which accept a similar plug attached to the rear of the receiver or transmitter. Four sturdy shockproof mounts are used at the corners of the rack, and two rollers are placed at either side of the forward portion of the frame, to aid withdrawal and insertion of the equipment.



The Most Important Job in Aircraft Production

THE biggest problem to be solved in achieving stepped-up aircraft production is the elimination of the "Bottle-Neck" of a possible shortage of parts, tools, and accessories. In Illinois, the second largest metal-working state in the nation, industry is geared to high-speed production and quick change-over to quantity manufacture of items for which a shortage may develop. The large number of Illinois Manufacturers already manufacturing and equipped to produce the vital parts and tools for aircraft manufacture is an added reason for the choice of an Illinois location for new aircraft plants and branch plants. In Illinois you gain all eight of the factors necessary to aircraft manufacture: GOOD LABOR SUPPLY—AVAILABLE MATERIALS AND PARTS—FINEST TRANSPORTATION FACILITIES—STRATEGIC CENTRAL LOCATION—IDEAL TESTING CONDITIONS—PLANT SITES NEAR AIRPORTS—EXTENSIVE RESEARCH FACILITIES—MILITARY TRAINING BASES.

Military, Federal, and Industrial authorities agree that American aircraft manufacturers and allied industries will benefit from locating in the Middle West, away from our vulnerable coasts. Investigate the outstanding advantages of locating your new plant or branch plant in the State of Illinois.

Special Confidential Report to Executives

Write the Illinois Development Council, at Springfield, today for a special report on the advantages of Illinois as they apply to the aircraft and parts manufacturing industry. This report will present the facts on labor, raw materials, available plant sites, power, fuel, taxes, distribution facilities, and other factors determining the selection of a plant location. Your inquiry will, of course, be kept strictly confidential. Write—

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● "YOU'RE O.K.— KEEP THE GOOD WORK UP!" . . . sweet words in any pilot's language. Just like it takes hard work and intensive study to qualify for this THUMBS UP "O.K."; Berry Brothers have for many years specialized intensively in the production of quality aircraft finishes. 3 out of 4 private, commercial and military ships are finished with Berryloid Aircraft Finishes. Time proven—they represent the utmost in durability, protection and beauty of appearance.

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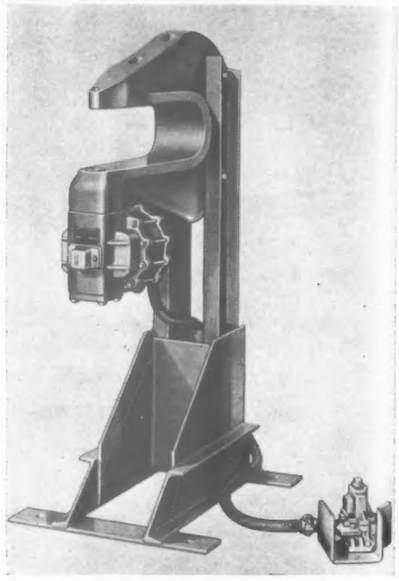
BUYER'S LOG BOOK

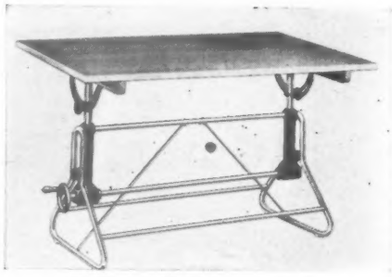
What's New in Accessories, Materials, Supplies, and Equipment

Designed for aircraft subassembly riveting, a new stationary pneumatic squeeze riveter, built by Hanna Engineering Works, 1765 Elston Ave., Chicago, has a 20 in. reach, 6½ in. gap, and is capable of exerting 10 tons on the rivet at 80 lb. air pressure. Ram is actuated by pneumatically operated mechanism of the wedge and roller type, and the rated pressure is exerted through a considerable portion of the 1½ in. ram travel. The long ram stroke avoids necessity for removal of dies which slows up riveting. Return of the piston is spring actuated, effecting economies in air consumption, and riveter is actuated by a foot operated valve which may be placed at a convenient point.—AVIATION, *April, 1941.*



Hanna pneumatic riveter

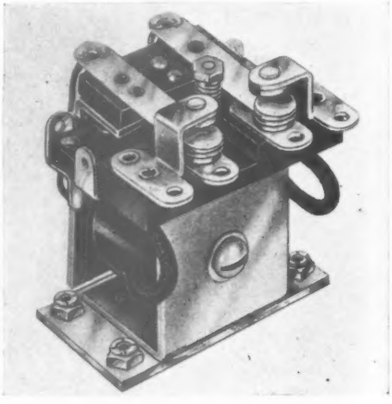
A revolutionary change in design and construction is claimed for the Primo Metapost drafting table by The Frederick Post Co., Minneapolis, Minn. Built of satin chrome tubular steel, with top made of selected soft textured pine 1⅛ in. thick, this Primo Metapost table, model 2280½, is readily and completely adjustable. By turning a free operating handwheel the working surface will raise from 35½ to 43 in. The top may be tilted from front to back at an angle of 60 degrees by means of 2 hand clamps. Table top sizes range from 31x42 in. to 48x96 in. Neat and streamlined, the appearance of this table will modernize and add attractiveness to the drafting room.—AVIATION, *April, 1941.*



Post drafting table

Designed especially for all-metal aircraft, a water-clear coating has been developed by Chemical Research Corp., Tulsa, Okla., known as Resistal HCL-340. Applications to metals and alloys showed no darkening after 3 years' exposure to weather, salt spray, water and brine immersion, acid and alkali, abrasion and ultra violet light. Easily pigmented, it can be used for camouflage, drying within a few minutes, and requires no primer or anodic treatment for permanent adhesion. Coatings are non-inflammable and insoluble in fuels or lubricants.—AVIATION, *April, 1941.*

A special line of precision-built aircraft relays, of which Type AO is representative, has been announced by Allied Control Co., 227 Fulton St., New York, N. Y. Designed for transmitters and receivers, flight instruments, control devices and remote control switches, all units are built around the dynamic balanced armature principle together with a stainless steel pin hinge to insure utmost reliability. All lugs and springs are said to be unusually rugged to allow for current carrying capacity greatly in excess of rated loads. Type AO, weighing 125 gr., is 1⅞x1 $^{9}/_{16}$x1⅝ in., and has a continuous rating on 24 volts DC of 15 amps.—AVIATION, *April, 1941.*



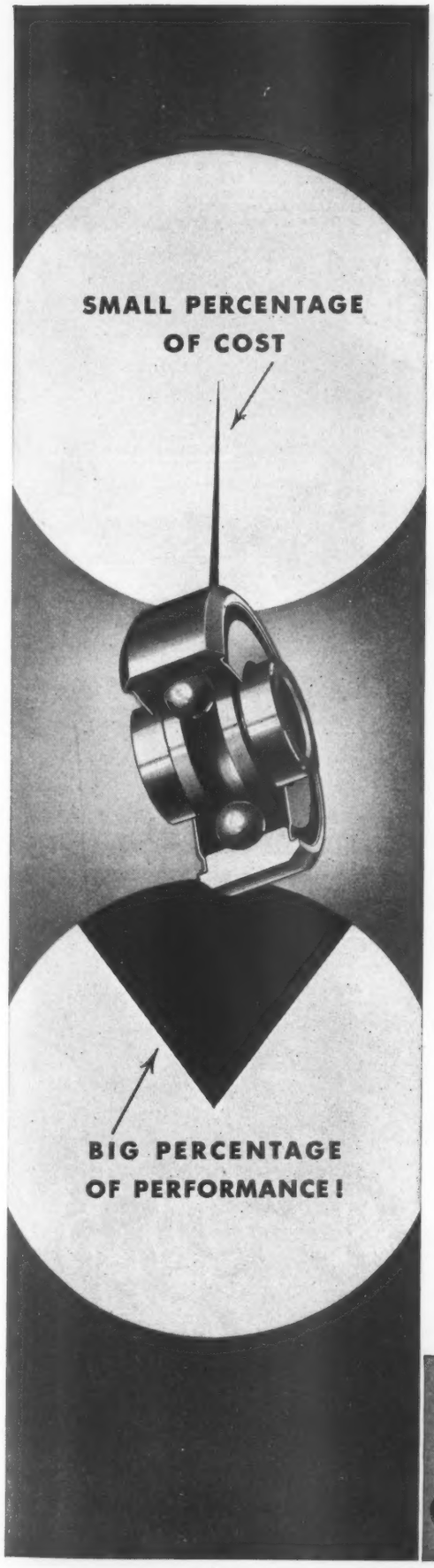
Allied Control Type AO relay

Cementing together in desirable bonded strength almost any two substances—such as rubber and/or fabrics to metal, plastics, wood, etc.—a new adhesive, Tempotite, is said to combine strength and plasticity in permanent waterproof bond where usual glues fail. Developed by Mauch & Merk Co., Inc., New York, N. Y., this pure rubber product is claimed to be weatherproof, stainproof and unaffected by temperatures from zero to over 300 deg. F. The liquid form can be sprayed or brushed, with a gallon covering 300 sq. ft., and will not effect silver or other metallic parts.—AVIATION, *April, 1941.*

A new "core feed" electric eraser, the Bruning Hollow Shaft Eraser, brought out by Charles Bruning Co., Inc., New York, N. Y., uses an eraser 7 in. long fitting into a tubular armature shaft. This long rubber core can be fed out as it wears down and tightened at the lower end by a chuck. Motor unit has an impeller-type fan mounted on the shaft within the light-weight die-cast aluminum motor housing, insuring cool operation, and operation is simplified by a sliding control button designed to fit under the index finger.—AVIATION, *April, 1941.*

Bruning Hollow Shaft Eraser

Perfectly timed with present-day defense measures is the new Tulca Safety Goggle Lens developed by Unives Lens Co., Dayton, O. Made of non-shattering material, the surface of Tulca lenses is 20 times more resistant to grit and hot



Small Percentage of COST...
Big Percentage of PERFORMANCE!

Shall your ship's control system be equipped with the finest ball bearings? With "cheap" ball bearings? Or with no ball bearings at all? . . . You are facing a decision more important than you may realize. Let's see what's at stake:

Cost? The difference in cost between high-grade aircraft ball bearings and cheap substitutes is about the same as that between high-grade and cheap upholstery material for your cabin. And just about as important, in relationship to the entire cost of the airplane. But remember, upholstery doesn't affect performance . . . or safety!

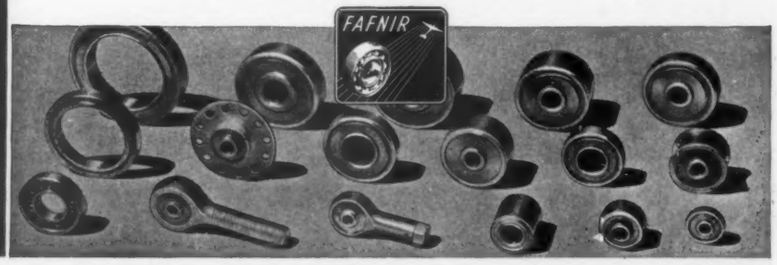
Ball bearings can—and do! That is why Fafnir builds extra values into these bearings, fabricating races from SAE 52100 steel, through hardened. Using one-piece design for both inner and outer races. Grinding them to precise limits of contour radius, pitch diameter, radial and lateral eccentricity.

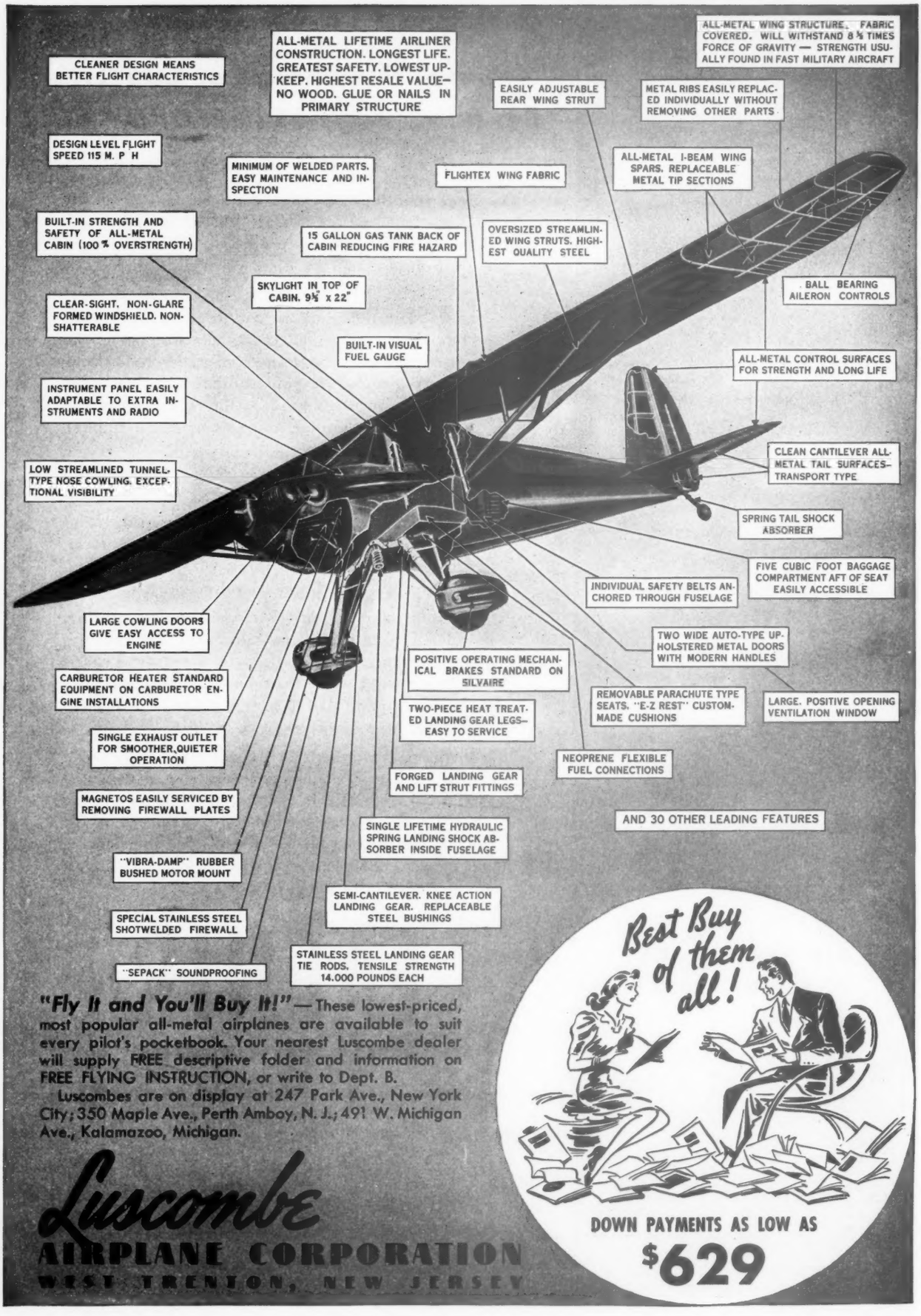
That is why Fafnir developed special plating, installed automatic greasing equipment that measures pre-lubrication to the fraction of a gram. That is why Fafnir makes more than one hundred inspections of Fafnir Aircraft Ball Bearings, with six basic, key inspections of *every bearing that we ship.*

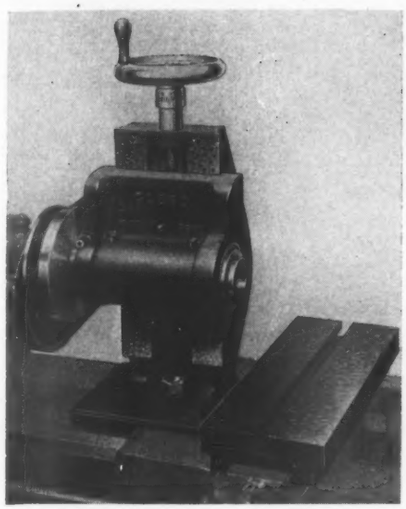
It isn't worthwhile to sacrifice sensitive, friction-free control to save a few pennies. The cost of the finest aircraft ball bearings is so insignificant a part of the ship's total cost that you can letter "Fafnir" at the right spots, right on your sketches, without unbalancing the budget. The Fafnir Bearing Company, Aircraft Division, New Britain, Conn.

FAFNIR
Ball Bearings

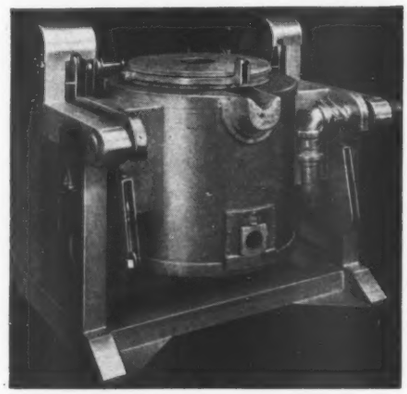
FOR AIRCRAFT ENGINES AND CONTROLS



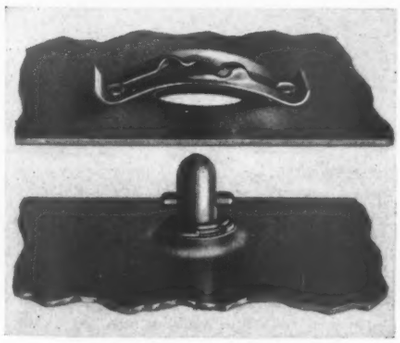

CLEANER DESIGN MEANS BETTER FLIGHT CHARACTERISTICS
ALL-METAL LIFETIME AIRLINER CONSTRUCTION. LONGEST LIFE. GREATEST SAFETY. LOWEST UP-KEEP. HIGHEST RESALE VALUE—NO WOOD. GLUE OR NAILS IN PRIMARY STRUCTURE
ALL-METAL WING STRUCTURE. FABRIC COVERED. WILL WITHSTAND 8 ½ TIMES FORCE OF GRAVITY — STRENGTH USUALLY FOUND IN FAST MILITARY AIRCRAFT
EASILY ADJUSTABLE REAR WING STRUT
METAL RIBS EASILY REPLACED INDIVIDUALLY WITHOUT REMOVING OTHER PARTS
DESIGN LEVEL FLIGHT SPEED 115 M. P. H.
MINIMUM OF WELDED PARTS. EASY MAINTENANCE AND INSPECTION
FLIGHTEX WING FABRIC
ALL-METAL I-BEAM WING SPARS. REPLACEABLE METAL TIP SECTIONS
BUILT-IN STRENGTH AND SAFETY OF ALL-METAL CABIN (100% OVERSTRENGTH)
15 GALLON GAS TANK BACK OF CABIN REDUCING FIRE HAZARD
OVERSIZED STREAMLINED WING STRUTS. HIGHEST QUALITY STEEL
SKYLIGHT IN TOP OF CABIN. 9½" x 22"
BALL BEARING AILERON CONTROLS
CLEAR-SIGHT. NON-GLARE FORMED WINDSHIELD. NON-SHATTERABLE
BUILT-IN VISUAL FUEL GAUGE
ALL-METAL CONTROL SURFACES FOR STRENGTH AND LONG LIFE
INSTRUMENT PANEL EASILY ADAPTABLE TO EXTRA INSTRUMENTS AND RADIO
CLEAN CANTILEVER ALL-METAL TAIL SURFACES—TRANSPORT TYPE
LOW STREAMLINED TUNNEL-TYPE NOSE COWLING. EXCEPTIONAL VISIBILITY
SPRING TAIL SHOCK ABSORBER
FIVE CUBIC FOOT BAGGAGE COMPARTMENT AFT OF SEAT EASILY ACCESSIBLE
INDIVIDUAL SAFETY BELTS ANCHORED THROUGH FUSELAGE
LARGE COWLING DOORS GIVE EASY ACCESS TO ENGINE
TWO WIDE AUTO-TYPE UPHOLSTERED METAL DOORS WITH MODERN HANDLES
POSITIVE OPERATING MECHANICAL BRAKES STANDARD ON SILVAIRE
CARBURETOR HEATER STANDARD EQUIPMENT ON CARBURETOR ENGINE INSTALLATIONS
REMOVABLE PARACHUTE TYPE SEATS. "E-Z REST" CUSTOM-MADE CUSHIONS
LARGE. POSITIVE OPENING VENTILATION WINDOW
TWO-PIECE HEAT TREATED LANDING GEAR LEGS—EASY TO SERVICE
SINGLE EXHAUST OUTLET FOR SMOOTHER, QUIETER OPERATION
NEOPRENE FLEXIBLE FUEL CONNECTIONS
FORGED LANDING GEAR AND LIFT STRUT FITTINGS
MAGNETOS EASILY SERVICED BY REMOVING FIREWALL PLATES
AND 30 OTHER LEADING FEATURES
SINGLE LIFETIME HYDRAULIC SPRING LANDING SHOCK ABSORBER INSIDE FUSELAGE
"VIBRA-DAMP" RUBBER BUSHED MOTOR MOUNT
SEMI-CANTILEVER. KNEE ACTION LANDING GEAR. REPLACEABLE STEEL BUSHINGS
SPECIAL STAINLESS STEEL SHOTWELDED FIREWALL
STAINLESS STEEL LANDING GEAR TIE RODS. TENSILE STRENGTH 14,000 POUNDS EACH
"SEPACK" SOUNDPROOFING
"Fly It and You'll Buy It!" — These lowest-priced, most popular all-metal airplanes are available to suit every pilot's pocketbook. Your nearest Luscombe dealer will supply FREE descriptive folder and information on FREE FLYING INSTRUCTION, or write to Dept. B.
Luscombes are on display at 247 Park Ave., New York City; 350 Maple Ave., Perth Amboy, N. J.; 491 W. Michigan Ave., Kalamazoo, Michigan.
Luscombe
AIRPLANE CORPORATION
WEST TRENTON, NEW JERSEY
Best Buy of them all!
DOWN PAYMENTS AS LOW AS
$629



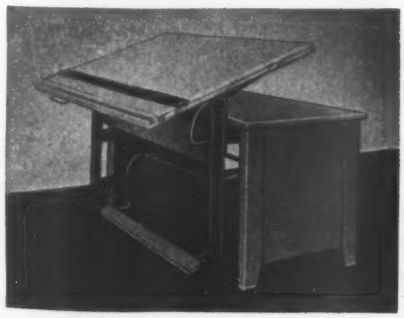
Globe milling attachment



Fisher Nose Pour Crucible



United-Carr Dot Cowl Fastener



Hamilton Auto-Shift table

metallic particles than tempered glass lenses. Splashing, molten metal has no effect whatever on the Tulca surface, and the weight of this lens is only 45 per cent that of a tempered glass lens, making the new material more comfortable to wear.—AVIATION, *April, 1941.*

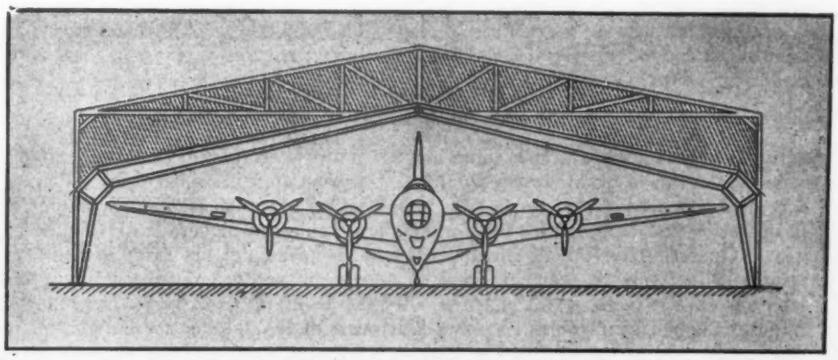
A new milling attachment made by Globe Products Mfg. Co., Los Angeles, Calif., employing the lathe spindle for its drive, makes use of the carriage movements to operate its table. Spindle, carried on verticle slide so it can be positioned up or down, is mounted on ball bearings and is fitted with No. 9 B. & S. taper. A ball bearing arbor support attachment to tailstock spindle permits application of a cutter arbor in manner similar to that on standard plain milling machine with an overarm. Overall dimensions of the table are 4¼x12 in.—AVIATION, *April, 1941.*

A timely aid to the production step-up in aviation is the Fisher Motorized Nose Pour Crucible Furnace made by Fisher Furnace Co., 1748 N. Kolmar Ave., Chicago, Ill. Especially adapted to melting aluminum and magnesium, it features a constant pouring arc. The pouring lip has been brought to the center of pivot by mounting of furnace on trunnions axised in line with the lip. This special mounting permits low construction thereby granting simplicity in charging and convenience in observation. Built in standard sizes for 150 crucible sizes and up, the furnace is available in oil and gas fired units.—AVIATION, *April, 1941.*

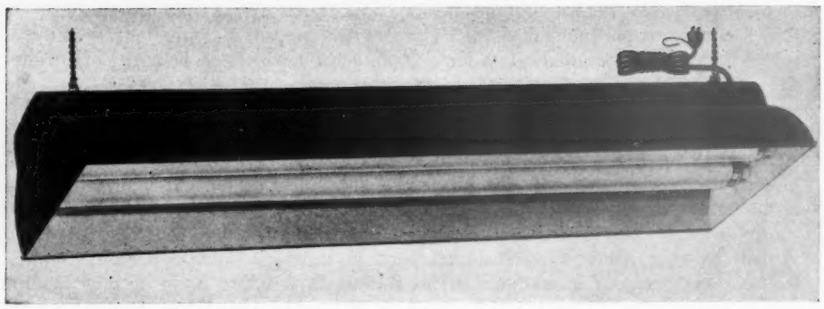
For fastening engine cowling, handhole covers, access plates, and similar parts, the Dot Cowl Fastener, made by United-Carr Fastener Corp., 31 Ames St., Cambridge, Mass., may be used readily on flat or curved surfaces. Self-aligning, due to rounded end on stud and the floating fit in the sheet, this fastener is adapted to variations of at least 3/32 in. in thickness without change of location of pin. It has about 1/8 in. pick-up; the spring is scientifically hardened and cadmium plated, and the stud, made of case hardened, cadmium plated steel, is positively assembled by the simple spring ring which may be attached or detached easily by screw driver or special attaching tool.—AVIATION, *April, 1941.*

Easy adjustability makes for easier drafting table work. With the Hamilton Auto-Shift table, made by Hamilton Mfg. Co., Two Rivers, Wis., it is no longer necessary to loosen hand wheels or do the actual lifting when adjustments are made. Pressure on a pedal releases a brake permitting the top to be raised or lowered with the finger tips to desired height. Tilting may also be accomplished with a similar mechanism.—AVIATION, *April, 1941.*

"Edgebends and Kneebends," designed and fabricated by Lukenweld, Inc., Coatesville, Pa., for assembly plant and hangar construction, save about 1/3 of cubic footage required by conventional design. Said to have the highest strength/weight ratio of any steel framing system, "Edgebends and Kneebends," requiring less steel tonnage, carry roof loads safely without interior columns. Offering improved appearance and maximum working space, "Kneebends" are carefully fabricated and furnace stress-relieved to minimize rolling and thermal stresses.—AVIATION, *April, 1941.*



Lukenweld "Kneebends"



Mitchell fluorescent lamp

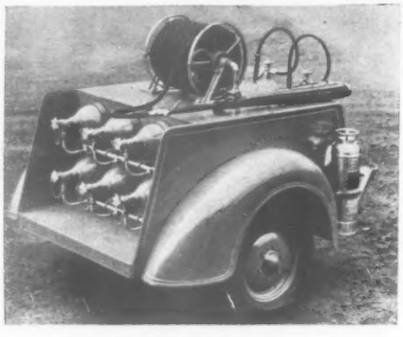
One of today's newest fluorescent lighting fixtures, Mitchell Model No. 2026, using two 100 w. T-17 bulbs, each 5 ft. long and 2⅛ in. thick, fills the need for high intensity illumination. Mitchell Mfg. Co., Chicago, Ill., has designed its power factor and stroboscopic corrected fluorescent unit for high ceiling installations. Bearing the Fleur-O-lier, Underwriters' Lab., and Mitchell guarantees, it conforms to over 50 rigid specifications for efficiency, soundness of construction and safety.—AVIATION, *April, 1941.*

Pittsburgh Plate Glass "Flexseal"

Safety glass having a strength 10 or more times greater than ordinary safety glass is said to have been developed by Pittsburgh Plate Glass Co., Pittsburgh, Pa. "Flexseal" laminated glass, developed initially for sub-stratosphere planes, combines the toughness, strength and elasticity of a special plastic plus the hard surface, good vision and rigidity of special heat-strengthened glass. Even when broken the thick plastic layers attached to the frame serve as an air-tight diaphragm, and unlike present windows does not tend to break when the frame is twisted.—AVIATION, *April, 1941.*

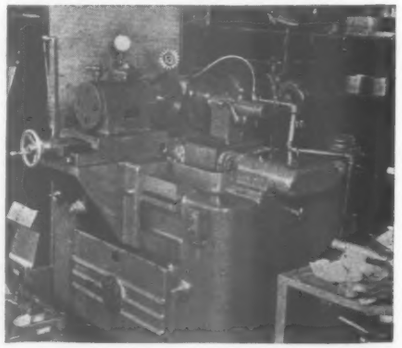
South Bend bench lathe

For precision operations on small work, South Bend Lathe Works, South Bend, Ind., have a new 10-in. swing 1 in. Collet Capacity Tool Room Bench Lathe. Mounted on an all-steel welded bench, having the rigidity and stability of a floor type, it is a back-geared, screw cutting precision tool with time saving features of an engine lathe. High spindle speeds, ranging from 50–1357 rpm., with smooth, vibration-free operation, are achieved by direct belt drive to the spindle. Headstock spindle bearings are unusually large, of integral type, and provide extreme rigidity. Bed lengths are 3, 3½, and 4 ft.—AVIATION, *April, 1941.*



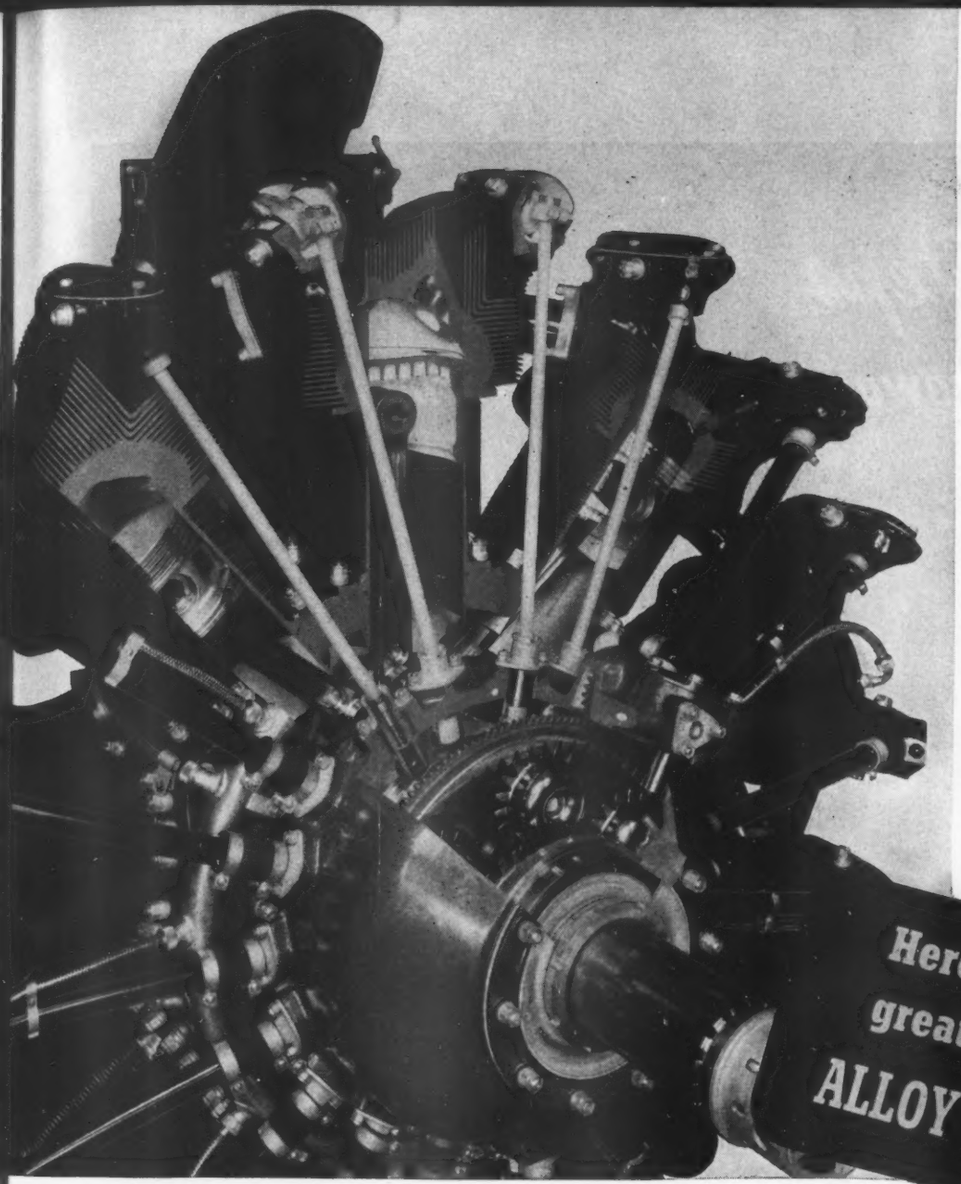
Kidde mobile unit

When a plane crashes and fire breaks out, quick and effective means of extinguishing the blaze are essential. A compact and versatile mobile fire fighting unit, perfected by Walter Kidde & Co., Bloomfield, N. J., has been designed to be hooked up as a trailer for emergency use. Six 50-lb. carbon dioxide cylinders, equipped with a hosereel and nozzle, are manifolded together and individually operated by valves on each cylinder, permitting use of all or any part of the unit's capacity as needed. For smaller fires, two portable extinguishers of 15 lb. capacity are carried on the front platform of the trailer together with two 2½ gallon pure-water extinguishers which operate on the principle of a syphon bottle, propelling a stream to an effective distance of 30 to 40 feet. Primarily this unit is designed for use on large fires of flammable liquids and electrical equipment against which carbon dioxide is especially effective and safe as it is a non-conductor.—AVIATION, *April, 1941.*



Mich. Tool lapping machine

Aircraft engine gears are now being lapped on a new highly flexible 2-lap lapping machine developed by Michigan Tool Co., Detroit, Mich. In spite of its ability to accommodate a wide variety of sizes and types of gears, the lapper is automatic in operation and designed for high production lapping of moderate and small size gears. Operating on the Michigan crossed-axis principle, the machine features relatively low surface speed of rotation and high speed of reciprocation of the laps across the faces which may be adjusted from 90 to 300 reciprocations a minute. Change gears permit ready adjustment of lap spindle speed from 52 to 283 r.p.m., and at the end of the lapping cycle one head and lap retracts, permitting ready unloading and loading.—AVIATION, *April, 1941.*



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DEFENSE FOR AMERICA

The Aviation Industry of our country requires steel in enormously increased quantities and of the most exacting standards of quality. Because this demand must be met, it is fortunate that Republic Steel, long before the present emergency was generally foreseen, began a program of production expansion and improvement. As an example, in the last two years Republic's electric furnace capacity has been multiplied 4 times. Today, every American-made airplane contains steel made by Republic.

In Republic plants, the men of Republic take pride in the new production records they are setting. The men of Republic are doing their level best to provide steel for the wings of America—***steel, first line of national defense.***

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The modern airplane engine—explosive horse-power compactly packaged to streak across the sky—a tribute to the makers of alloy steels. Many of these alloys resulted from Republic research. Each is the finest for its specific use—saving weight—providing greater strength—resisting vibration, wear—working safely at high temperatures.

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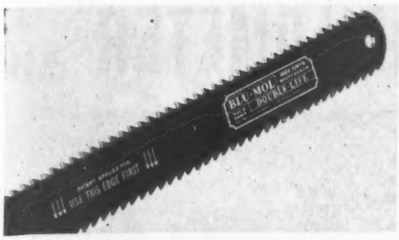
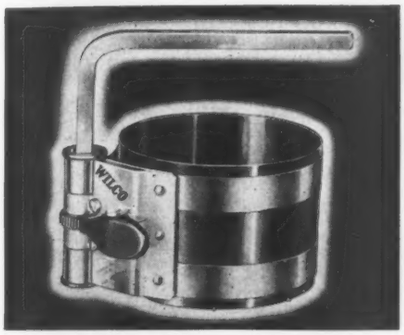


Millers Falls hack saw blade

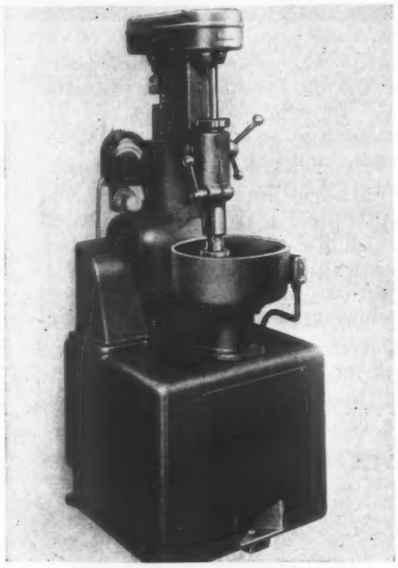
Two cutting edges on a single hack saw blade—an old dream of metal working men—are featured in Double-Life Blu-Mol, developed by Millers Falls Co., Greenfield, Mass. The blade costs only 50 percent more than the single-edge type and is said to do twice as much work per blade at a cutting speed twice the usual maximum. Teeth along the first cutting edge are set fractionally wider than along the second, eliminating drag and wear. Guaranteed shatterproof and unbreakable, this blade has a special heat treatment which leaves teeth hard, ends and center soft.—AVIATION, *April, 1941.*



Wilkening piston ring compressor

A new piston ring compressor, featuring the positive ratchet lock and two tension bands of special steel, called Wilco Master-Universal ring compressor, is made by Wilkening Mfg. Co., Philadelphia, Pa. Lock eliminates any slippage of compressor bands while piston and ring assembly are pushed into the cylinder. The tension bands keep all rings under full compression until they are in the cylinder. Two sizes are available; MU-5, ranging from 2⅛ to 5 in. diameters, and MU-7, 3½ to 7 in. diameters.—AVIATION, *April, 1941.*

Providing a means for rapid coupling or uncoupling of push-pull, reciprocating and rotary control units, a new line of control couplings especially adapted for use on controls with an outside casing and inner wire or cable, has been developed by Dycer Aviation Supplies, Los Angeles, Calif. The coupling may be installed at any convenient point in the control system, permitting uncoupling at the point selected and so materially simplifying maintenance work.—AVIATION, *April, 1941.*



Ultra-Lap lapping machine

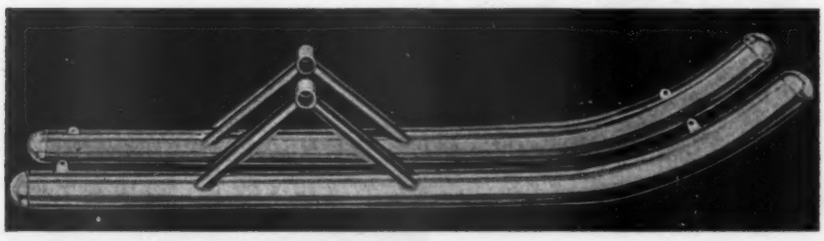
Lapping by machine in production quantities is claimed by Ultra-Lap Machine Co., Detroit, Mich., for a tool said to increase production 700 percent as compared to hand lapping. A precision as to flatness of less than 12 millionths of an inch and smoothness of under one micro-inch is guaranteed. Any metals or materials, hard or soft, are adaptable, to the new quantity production.—AVIATION, *April, 1941.*

Tubular slide-contact rheostats widely applicable to aircraft laboratory use are offered by the Rex Rheostat Co., New York, N. Y. The Rex rheostats are of rugged construction and of high watt capacity. Self lubricating metal brushes assure smooth movement without wearing the resistance wires. An enclosure protects the rheostat from mechanical damage and protects the user from shocks and burns.—AVIATION, *April, 1941.*

To meet the demands for heavy machine tools in the preparedness program, the new super V-60 DOALL is now being built by Continental Machines, Inc., Minneapolis, Minn. Featuring a 5 foot throat depth, the actual diameter of any work cut on this model can be 10 feet. Thicknesses up to 12 in. can be handled with speed and precision since the machine uses narrow band DOALL precision saw blades varying from ☆ to one inch in width. An hydraulic contour feed control used in connection with the power feed provides easy operation, and the Speedmaster variable drive furnishes every speed from 50 to 1500 ft. per min., thus suiting the exact cutting speed to the particular material handled.—AVIATION, *April, 1941.*

Continental DOALL V-60

Lightplane skis of steel tube design have been added to the line of accessories manufactured by the Heath Co., of Benton Harbor, Mich. All-welded steel construction is featured on this ski, permitting easy taxiing on snow or ice, and is said to resist freezing to surface. All parts are rustproofed inside and out. Installation is quickly made on all planes up to 1310 lb. gross. Attaching parts are included with the skis which weigh 28 lb. per pair.—AVIATION, *April, 1941.*



Heath lightplane skis

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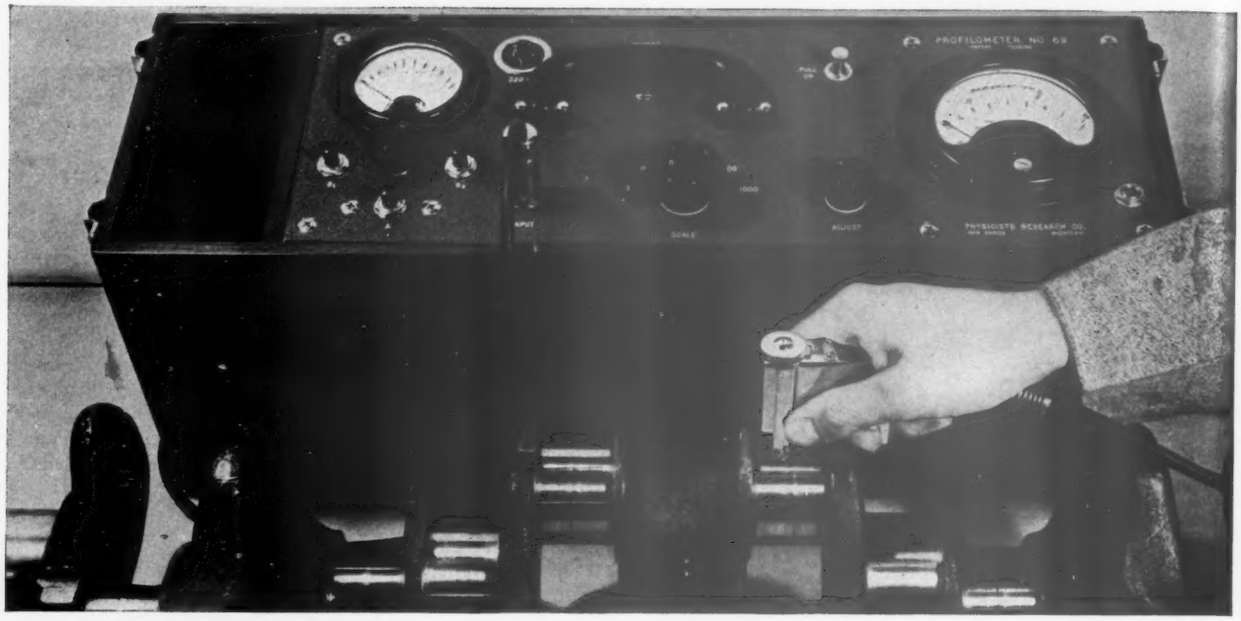

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THE AVIATION NEWS

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APRIL 1941

2 Million for Planes in Aid Appropriation Resulting Expansion Will Not Be Immediate

Washington (AVIATION Bureau): There is big money for aircraft in the British aid appropriation, but it would be rash to assume that provision of $2,000,000,000 for planes and additional hundreds of millions for plant expansion means an immediate step-up of the plane program. Lend-lease has many important financial and bookkeeping angles for aircraft industry, but it is easy to overestimate its effect as a production matter.

For some time now, the limit on output has not been the amount of money available but rather the physical capacity of the industry. Thus the only planes available for lease-loan to Britain are those few still on hand and those now being delivered on existing U. S. and British orders.

Need of large additional appropriation arises from the clause in the British aid act limiting to $1,300,000,000 the value of armament which may be given from materials now on hand or appropriated for. Much of this allowance is being used up in deliveries from existing stocks. So in order to deliver current production to Britain new duplicating orders must be placed.

Then, as planes come off the line, deliveries on the original orders can be deferred and the goods be accepted on the new orders for Britain. In effect, the program is not being increased so much as extended farther into the future.

Thus the money in the Lease-Lend covering appropriation is mere duplicate money to make existing orders available for aid to Britain. Actual expansions of the plane production program will be provided for in other appropriations, which, coming after the L-L bill passed, are not subject to the $1,300,000,000 limit. First example of this was the money for the 3600 bombers to be built in Government-owned plants from parts fabricated in Detroit. The $524,000,000 for these ships was covered by a contract authorization in the fifth supplemental appropriation, which also included cash to pay for the assembly plants and to make payments on contract authorizations approved last year.

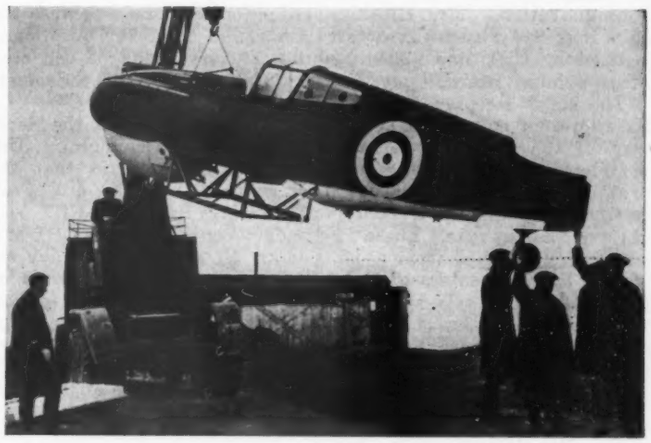
Military secrecy will increase as a result of "lending" planes because the Army can now lay it all on the interests of somebody else. Secrecy will be the reason why you will not be told what planes are sent abroad.

Engine Output Nears Parity With Airplanes Higher Power Progress in Air & Liquid Types

Washington (AVIATION Bureau)—To increase engine production is still among the most urgent objectives of the defense program. But engine production is steadily catching up with plane production. In fact, if all American engines went into American planes, there would be more than enough. Plane production in January, for instance, totaled 1,024 (36 commercial planes, about 600 trainers, about 400 combat types). An average of two engines per plane is required, or about 2,000 engines. Actual engine production was about 2,400. However, some 600 engines were shipped to England for installation in British planes, leaving a deficit of 200 engines.

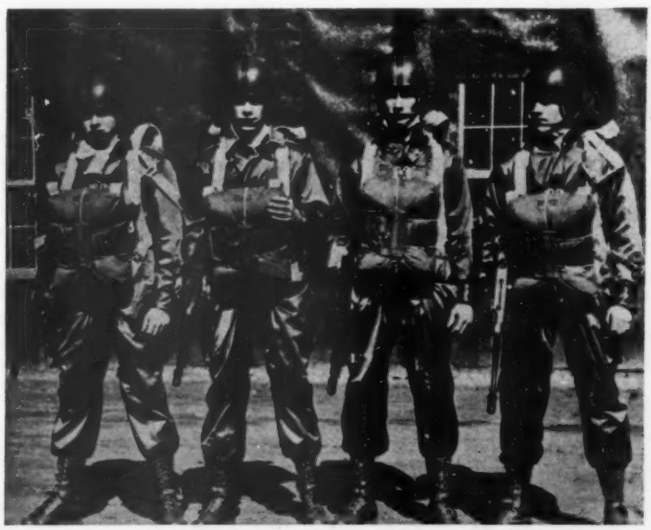
This picture is a little overoptimistic. The engines going abroad in crates are nearly all of the high-powered combat types, which results in the engines available here not always matching up with the planes which need them. Moreover, it does not allow for the fact that in a few cases plane production is being deliberately held down

(Turn to page 106)



Harris & Ewing

A Curtiss fighter in England after it has arrived by ship. Airplanes are uncrated as rapidly as possible and moved into assembly sheds where mechanics add wings, tail surfaces, landing gear and other equipment.



LOOKING LIKE A HIGH POWERED BACKFIELD on a football team, these four parachutists of the 501st Parachute Battalion are wearing "Tackle Twill", a rayon fabric widely used on the gridiron in recent years. The cloth is tough and smooth, which helps in preventing the shroud lines from fouling the jumper, according to William Skinner & Sons, manufacturers. Parachute troops are in training at Fort Benning, Georgia, where the original battalion forms the nucleus of further expansion. It is thought that parachute troops may operate with extraordinary success in the western hemisphere, in wide open spaces which any invading enemy could not defend. Troops carry a wide variety of equipment on their persons, and more follows them on cargo chutes.

4,813 CPT Grads Accepted By Army and Navy; 11% Attrition Rate; "Policy Board" Suggested

Washington (AVIATION Bureau)—Army and Navy have accepted 4,813 graduates of the CPT program who have volunteered for service, according to Robert Hinckley, Assistant Secretary of Commerce, who is in charge of Civil Aeronautics Administration. Mr. Hinckley said that 914 flight instructors trained by CPT had gone into other aviation activities.

The 4,813 accepted for Service represent more than 11 percent of the students who have completed CPT preliminary training and about one-fourth of the total number trained in the secondary phase. These figures were compiled from a canvas of the 907 centers of training, and include only those men now actually in Army or Navy training, and those who have been accepted and are under orders.

"These are impressive figures," Mr. Hinckley said, "when one considers that the great majority of the boys who have taken the training are still in college completing their studies." The boys still in school are not available to the armed forces, as a matter of national policy, unless they choose to volunteer. They are deferred in the draft until the end of the school year.

Of the Army cadets who started primary training in January, the record shows that about one in five were CPT trainees, Mr. Hinckley said.

Of the 914 flight instructors trained in CPT, the largest group—468—went to give flight instruction in the Army's civilian training centers. Mr. Hinckley said that these men virtually have staffed the Army's expansion of this type of school. Twenty-seven other instructors went to teach Naval aviation, and 117 to teach in Canadian flight centers; ninety-six went to active duty in the Army; 26 with the Navy; 207 went to the airlines to train as replacements in co-pilot personnel. Despite this large outgo of instructors, Hinckley said, there will be no shortage, as more are being trained to take their places.

To date, 37,277 pilots have successfully completed the CPT student course, 3,911 of them in the secondary phase. A total of 2,063 instructors have been given refresher courses.

Commerce Department's budget request for $18,000,000 for CPT training in fiscal 1942, beginning July 1, was still pending before Congress as this was written, with much testimony still to be taken by appropriations committees. This budget estimate was only about half of the $37,000,000 given to CPT last year. Apparently the reduction was made because the Army and the Navy questioned the military value of the civil training in view of the emergency.

But it seemed that the Service views were changing. Unofficially it was said that the Navy now wants to accept all volunteers from the CPT secondary course. These CPT students are given some Navy endoctrination and permitted to skip the first 33-hour session. It is said that Navy also wants all the CPT instructors it can get. Navy of course has a valid objection to the use of too many ground trained men, because its operations are primarily maritime.

The Army is reported pleased with CPT's primary students, but not so enthusiastic about the secondary graduates. Induction of primary CPT boys gives the Army a washout rate of only 16 percent, whereas its own recruits, who have had examinations only, are said to washout at the rate of about 40 percent. This is a worth while saving in time and expense for the Army. Reports say that the Army still does not like the CPT's secondary output; it believes that after the first few hours, training should be genuinely military.

While the Army does not yet ask men in school to enter the service, it is not entirely clear why, with aviation as fascinating as it is to most young men, more of them do not volunteer. The probable answer is that even those who wish to make a career of aviation do not like the idea of a three-year hitch. It has been unofficially suggested that one year's enlistment, with two years of reserve duty, might work out.

Another unofficial suggestion floating around in CAA is that a "Policy Board" be set up, consisting of three men; one from Army, one from Navy, and one from CAA, to coordinate the CPT program.

CAB Reports NASAO Meet

Means of preventing sabotage at airports and enforcing air traffic regulations are discussed in a report by the Civil Aeronautics Board on the first Regional Safety Conference on airport traffic problems held last December in Columbia, S. C., under auspices of the National Assn. of State Aviation Officials.

The report recommended placing the vent lines of underground storage tanks at least 10 ft. above the ground, as a safeguard against sabotage. It was also suggested that refueling trucks and hose lines be locked up securely when not in use, and that oil be placed under lock, or guarded closely. A constant check of oil and gasoline for contamination was recommended.

To obtain strict enforcement of airport traffic regulations, the report suggested an increase in the authority of airport managers. Beverly Howard, manager of the Charleston, S. C., airport, suggested that the CAB employ airport managers as "dollar-a-year men" and delegate to them the responsibility of enforcing safety regulations. At present, airport managers have little authority unless police powers are delegated by the municipality.

Other topics discussed in the report involve control of student training at various types of airports; methods of marking runways and means of disseminating notices of change in regulations.

Congress Studies Gliding

Congress has under consideration several bills directing the Civil Aeronautics Board to set up a glider-pilot training program designed to create a reservoir of pilots for defense purposes. Because of the proven success of glider-pilot programs in Germany and Russia and the enthusiasm in this country, for the civilian pilot training program with light planes, these bills are likely to get more serious consideration now than they would have previously.

Representative John M. Costello of California, was pushing for hearings before the House Interstate Commerce Committee on his own and on similar bills by Reps. Cole, Randolph, Fish, and Sen. McCarran. He was expecting a report on the measure from Assistant Secretary of Commerce Hinckley.

American Glider Assn. is stressing the urgent national defense aspect of the legislation, and has suggested a program for the training of 50,000 expert glider pilots this year and from 150,000 to 300,000 each succeeding year.

NAA Campaigns for Line Planes and Safety

In recent weeks the National Aeronautic Assn.'s Washington Newsletter has been pounding away with factual argument as to the need, in terms of trade and national defense, of building up a reserve of transport. It appears now that OPM intends to be quite liberal in the release of DC-3s to the lines, barring sudden changes in world events which might upset the whole picture. NAA undoubtedly will come in for credit, in proportion to its energetic work, if things turn out well.

Before the air safety issue had come to a head, with investigations ordered both in Senate and House, NAA was first to offer a specific program of corrective measures; these appear to have been thoughtfully received in Congress. The policy of NAA has been to build public confidence in airline safety by bringing the situation

Rudy Arnold

Army camouflage school at Ft. Belvoir, Va., where engineers study the effect of various paints and designs in hiding airports, factories and other strategic objectives.

frankly into the open and showing how the causes of recent accidents can be overcome.

NAA's annual meeting has been announced for Louisville, Ky., the first four days of June; will include annual Aviation Forum, with emphasis on air defense of the Western Hemisphere.

AA Tries Super Gasser

American Airlines is conducting high-altitude flight tests on a new blend of fuel which, when added to high test gas, boosts the power to aviation gasoline requirements. Engineers of the airline and specialists from the Cooperative Fuel Research Committee say they believe it may aid in the production of aviation gasoline for defense. The experimenters have been flying an American Airliner on a series of 3-hr. tests up and down the eastern seaboard from Boston to Washington, checking engine temperatures at various speeds, altitudes and stages of flight.

NWA Develops Masks

The comfort of the oxygen masks used by Northwest Airlines on its transport planes was praised by Emery M. Ellingson, assistant chief of the safety rules and education committee of the Civil Aeronautics Board, when he visited the Minneapolis & St. Paul base of NWA to conduct a survey, with a view toward drafting specific regulations for use of oxygen on all commercial airlines. With him are Pilot Ollie Yeates and Dr. W. R. Lovelace of Mayo clinic, co-designer of the masks and equipment now used on NWA planes. Ellingson commended Northwest Airlines for its pioneering in the use of oxygen on its planes. Use of oxygen is now required above 10,000 ft. for 30 min. or more and at all times above 12,000 ft.

Dentist To Explore In Culver Cadet

Dr. Cecil Smith, assistant professor of operative dentistry, Stanford University, will fly his specially equipped Culver Cadet over uncharted wilderness of Central and South America. Accompanied by his cousin, Dr. Joseph H. Lorenz, Burlingame, Cal., Smith will make a six weeks exploration trip. The flying doctors plan to follow PAA's route part way before branching off into unknown territory. Included in itinerary is Brazil where jungle still holds secret of Redfern disappearance.

Spot Checking

NAA is proposing that the Government extend airline intermediate fields and build new ones for alternate use in bad weather.

American Legion is putting special emphasis on developing an aviation policy; Col. G. de Frees Larner, of NAA, is chairman of The Aviation Commission Department of D.C.

Aviation gasoline: unlimited export to all British countries is authorized by State Department; will curtail our storage rate; we have plenty for any immediate use.

Corpus Christi, Navy's new air base and training center, opened March 12.

Soldiers in flivvers, armies in the air, one man to a hedge-hopper with machine gun and small bombs, proposed by Col. Roscoe Turner and others, is in general discussion stage.

Washington Airport will be put in service in April or May. John Groves, assistant chief of CPT, has been appointed manager . . . Bennett Griffin, veteran airline inspector, is new chief of the Standardization center at Houston.

Four Air Corps replacement centers are being established to speed training of pilots and technicians; recruits get basic training, uniforms, vaccinations are then sent to one of the 28 flying schools or technical school. Previously, they went directly to the schools.

Parachute troops' pay will be increased $500 a year per man if a bill sent to Congress by Secretary of War Stimson is passed—probably will be. Four parachute battalions will be organized in 1942.

New two-place plane will soon be announced by Interstate Aircraft & Engineering Corp.; side-by-side; company says will out-perform present planes in price class and have features not available in its type.

Army is considering raising its present objective of 24,000 pilots; if it does, far more facilities will be needed.

The grade of Aviation Cadet in the Air Corps is proposed in a bill before Congress, almost sure to pass. In addition to improving status of air cadets it puts them on equal footing with Marine and Navy aviation cadets.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Air Infantry Next

The Stubblefield award goes to Rep. Charles Cramer, who said he would introduce a bill requiring airlines to provide chutes for passengers and give them jumping instruction before takeoff.

A Messerschmitt 110 German twin-engined fighter, shot down in England, was unloaded at a Brooklyn dock and shipped to Los Angeles for inspection by manufacturers of planes for the Air Corps and for Britain. There is little doubt other German planes were brought here secretly when the United States was more careful of its neutrality than it is now.

You haven't seen more than a good beginning of military aviation yet. Air infantry is now being developed by the Army. This differs from parachute infantry in that the troops are landed on the enemy ground in the plane. This will be highly technical strategy, requiring absolute advance information, including weather. Much might be done with troops in planes that could land on a spot.

Manufacturers still insist, though they are cooperating in the plan, that the inland aircraft assembly plants were almost entirely political—located to give the interior a break with the coasts for defense money. Any invasion of the United States, they say, would not come through the Navy and the armed coastal cities, but through the North and South borders, with intent of dividing the country. Those prairie plants would be first to go.

If you want an airplane, you'd better study the advisability of getting it now. It looks as if the priority on aluminum for defense might soon put the quietus on all "private" aircraft production, except equipment for the Civil Pilot Training Program. CPT may be expanded, or curtailed; no one can tell yet. And if any manufacturers try to go back to steel tubing and wood, priorities on skilled labor probably would nip that in the bud, too.

In a military operation involving the Navy and not the Army, it is probable that some Air Corps dive bombers and other combat craft would be transferred to the Navy's air arm. Gen. George Marshall, Chief of Staff, so advised military affairs committeemen, according to reports from the hearing room. Conversion of an Army plane for shipboard use is not much of a task, Army technicians said. It involves the installation of an arresting hook, and some beefing up.

What Britain will do with the three Boeing A-314 boats to be taken over from Pan American Airways is not officially known. But plausible opinion in Washington is that they will be used to ferry pilots back to the U. S. after they have ferried combat planes from the U. S. to England. Number of planes being flown across is rapidly increasing and will be further augmented by spring weather and the threat of invasion. The Boeings can carry more than 50, (less cargo) in berths, up to 70 in chairs.

100 ships at Martinique, built by the U. S. for the French, still stand in the open, but in grease and canvas, growing obsolescent. Neither Vichy nor Paris governments can touch them, because of the British blockade. The U. S., if we entered the war, would seize them instantly. Otherwise, if the war drags on, they will go bad in the humid air.

Rubottom's Shangri-La

A home-owners' Shangri-La, with airplanes for commuting between home and business, seems close to reality. Mr. and Mrs. H. W. Rubottom, Burbank, Calif., are now organizing a real estate subdivision built around an airport and laid out exclusively for plane-owning home-owners. The Rubottom home-port is about 20 miles north of Santa Monica, adjoining the beach and coast highway. Runways 2,000 ft. long are to be provided and each home-owner will live on a plot of land adjoining the runways. Hangars are to be erected near the individual homes.

Du Pont Plans Expansion

All American Aviation announces intention to file with the CAB for six new air mail pickup routes, to serve 175 additional cities and towns in New York, Massachusetts, Connecticut, Rhode Island, New Jersey and Pennsylvania. Two schedules a day are planned over the new routes, one in the morning and one in the afternoon, according to Richard C. du Pont, president. Most of the towns to be served have no airports. The system as yet is not carrying passengers but is studying the passenger service needs of towns that have airports.

Calling Names

Guy W. Vaughan, president of Curtiss-Wright and Wright Aeronautical is elected a director of Western Electric Co.

Frederic H. Leggett, treasurer and director of Western Electric retires after 43 years of service; his post is taken over by **George B. Proud,** asst. treasurer.

Richard S. Boutelle is relieved of duty in the War Department to assist in production of Fairchild Engine & Airplane Corp.'s new trainer.

Miss Burke, American Airlines hostess, is traveling the Northeast lecturing and showing movies to high school students to interest them in air transport.

A TCA pilot was sent to look for himself recently after a resident saw him practicing flight maneuvers in a new Lodestar and reported him in trouble.

Robert O. Barber, appointed manager of UAL's New York tour department.

Laigh C. Parker, vice president in charge of traffic for Delta is elected president and **D. C. Walker** fills the vacancy.

Fitzgerald brothers—five of them—all fly. Beall is American Airlines captain; Robert is CAA aide; Glenn is Air Corps instructor; Walter is Braniff captain; Jack is CPTP student.

Richard R. Stoddart, vice president and general manager of Lear Avia of California, resigns to start his own business, Stoddart Radio Co., Hollywood, Calif.

John Groves, assistant chief of Civilian Pilot Training Division of CAA, is named manager of new Washington National Airport.

GOOD WILL FLIGHT OF THE CUBAN NAVY extends to 22 republics of the Americas, covering 20,000 miles. Here are (l. to r.) Lt. Juan Montenegro, pilot; Commander Oscar Rivery, navigator and co-pilot; and Sergeant Frank Medina, mechanic, before their Wright Whirlwind-powered Howard monoplane "Teniente Menendez" at Floyd Bennett Field, just before taking off on their last lap.

Bennett H. Griffin, lately in charge of Instrument Training School at Wayne County Airport, Detroit, is appointed chief of new standardization center of CAA at Houston.

Edward V. Whallon goes to Philadelphia as district traffic manager of United Air Lines. Had been in New York office eight years.

Lt. Col. A. R. Harris, General Staff, gives luncheon for newly arrived Mexican Military Attache, **Col. Cristobal Cardenas** and newly arrived Assistant Military Attache for Air, **Lt. Col. Jose Allende,** outstanding Mexican aviator.

Kenneth Walker is appointed district traffic manager at Dallas for Braniff Airways, succeeding **William McPhail.**

E. J. McPhee becomes general superintendent of Dodge Truck Division, Chrysler Corp.

George H. Tweney, formerly in charge of Pan American's engineering office, joins faculty of University of Detroit as instructor in aeronautics in the College of Engineering.

A. S. Keller is elected vice president in charge of sales for Chicago Metal Hose Corp. **A. B. P. Johnson** is elected vice president in charge of production and **D. Wendell Pentress,** vice president in charge of special technical developments. **J. P. P. Parrar** is president.

Lincoln A. Bock owns distinction of being first man ever to work his way through an airline four-year apprentice mechanic's course. In 1936 he joined American Airlines as helper in the hangars, for next four years worked all day and attended classes at American at night, now has his A & E certificate and is mechanic in American's engine overhaul department at LaGuardia Field.

Capt. T. B. Herndon succeeds **Douglas O. Langstaff** as aeronautical coordinator for Louisiana. Herndon has twice been state governor of NAA and feels that a new civilian airport is needed in the vicinity of New Orleans.

Capt. James C. Graham, Penn Central pilot, is named chief pilot of the line's new Pittsburgh-Birmingham route.

Esten Shumate is appointed advertising manager for Mid-Continent Airlines, with headquarters in Kansas City. **Capt. R. P. Harris** is named assistant operations manager at Kansas City. He was formerly assistant superintendent of flying at Minneapolis. **A. P. Hinshaw** is transferred from Kansas City to Omaha as district sales manager, and is succeeded at Kansas City by **Charles E. Britten.**

Robert J. Lancraft becomes general manager of the Elmira Area Soaring Corp., following resignation of **Maurice L. Waters.** Lancraft is secretary-manager of the Elmira Assn. of Commerce and will direct both civic organizations.

Marion P. Crews, for nine years aviation engineering official in government agencies, is promoted to chief of the CAA Airworthiness Section, succeeding **Jack G. Gray** who goes with the Aero Chamber of Commerce.

E. V. Fox, C. C. Struhar, J. L. Wilson, V. A. Lundberg, J. P. Kirkpatrick, and **H. E. Gifford** receive Pioneer pins for ten years of service with American Airlines.

Richard M. Huber is appointed project engineer in charge of airways engineering department of TWA to replace **M. Tucker,** who accepts position with Airport Commission of Los Angeles. **William M. Schwarz** is elevated to Huber's former job. **Gene Gordon** joins CAA as airport engineer, his job of design engineer going to **Charles L. Lundblad.**

Emory B. Bronte gets extended leave of absence from Tide Water Associated Oil to enter service in the Navy. He is assigned to the Priorities Committee for the Army and Navy Munitions Board, with headquarters at Washington.

E. R. Stettinius, Jr., director of priorities, announces complete personnel of the Commercial Aircraft Priorities Committee as follows: **Arthur B. Whiteside,** executive officer, **Col. John H. Jouett, Col. Donald H. Connolly, G. R. Smith, Capt. D. C. Ramsey, Col. E. L. Lyons,** and **Merrill C. Meigs.**

M. Grzesuick, Robert Burns, Floyd Hall, and **Thomas A. Moffett** receive cash awards from Pratt & Whtiney for making four best suggestions during 1940. **H. M. Horner,** gen. mgr., and **G. H. D. Miller,** factory manager, presented the checks.

C. L. Kauderer, TWA district manager at Dayton, goes with Pan American as district sales manager for the new Cleveland office. His post is taken over by **Vernon Gunn,** who is succeeded as district manager at Amarillo by **J. D. Harrigan. J. J. Meade** of the N. Y. sales office gets Harrigan's post.

Capt. Bledsoe Payne, veteran pilot of American Airlines, builds model locomotives for relaxation,—won prize at the N. Y. Railroad Show.

Brig. Gen. Richard F. Cox, Brig. Gen. Edgar B. Colladay, Brig. Gen. Oliver L. Spiller and **Brig. Gen. Harvey C. Allen** command newly organized Coast Artillery Anti-aircraft Brigades at Camp Stewart, March Field, Ft. Bliss and Camp Hulen respectively.

D. W. Tomlinson reads paper before Southern California Section of SAE, predicting long range bombers at altitudes over 40,000 ft. in near future.

Ernest C. Low assumes duties of general manager of sales for John A. Roebling's Sons. Has been with Roebling 32 years. **Percy Jenkins** becomes manager of the New England district.

H. P. Schotters is distributor of Hobart Arc Welders in northern Indiana and western Michigan, with headquarters at Koontz-Wagner Electric Co., South Bend.

I. F. Pohlmeyer becomes sales engineer for Pacific Coast territory for Ohio Seamless Tube Co.

A. W. Doran is assigned to special duties in connection with railroad and government sales for B. F. Goodrich Co. **B. E. Silver** is transferred to government sales in Washington. **W. E. Nees** succeeds him as sales representative of mechanical division in Indiana with **Ralph Barcus** succeeding Nees in the West Virginia territory.

Thomas E. Dunn resigns as director and works manager of The Bullard Co. and **Foster P. Whitworth** is made works manager.

Addison C. Armstrong joins Worthington Pump & Machinery Corp. as manager of the Ordnance Division, at the Holyoke works.

J. C. Merwin is elected to take the place of **C. R. Messinger,** president of Chain Belt Co., who suffered a fatal heart attack on Feb. 4.

Allyn Harris, president of Cardox Corp., announces five executive promotions: **J. H. Bell** to executive vice president; **Eric Geertz** to vice president in charge of fire division; **Harry Ensminger** to general sales manager of same division; **Lawrence E. Lawson** to vice president of carbon dioxide gas division; and **Dr. C. A. Getz** to director of research.

F. H. Lindus, formerly Los Angeles branch manager of Service-sales for Timken Roller Bearing is transferred to Canton for general sales promotional work; **L. J. Halderman** takes his place; **Jack Gelomb** succeeds the latter as branch manager of Service-sales at Chicago; **Joe Jesseph** fills Gelomb's place at Detroit.

Stewart J. Hieronymous is associated as sales engineer with **L. P. Henderson,** manager of the San Francisco office of Lincoln Electric Co.

Seth Klein joins Marmon-Herrington Co. as assistant to vice president, **Bert Dingley.**

C. I. MacGuffie is appointed manager sales, Electric Welding Section of General Electric.

Rensselaer W. Clark is elected president and director of Hayes Mfg. Corp. **William B. Cudlip** and **Ira A. Moore** also elected directors. **Dr. Tracy C. Jarrett** moves to Baltimore to take over new duties as chief metallurgist for Koppers Co.

Clinton E. Swift heads development, production and distribution of Ampco-Trode for Ampco Metal Inc. **T. P. Samuels** is transferred from Milwaukee to Burbank, under **O. D. Cooper.**

J. R. Ackerman is appointed director of merchandising and advertising for Dodge Division, Chrysler Corp.

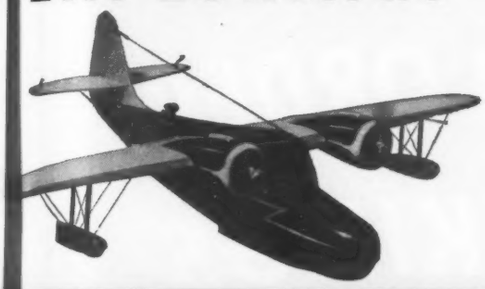
John Payton handles Indiana and east central Illinois territory for Reznor Mfg. Co. as district mgr.

Howard P. DeVilbiss and **Roy A. Guyer** are elected vice presidents of DeVilbiss Co. **Allen D. Gutchess** is reelected president.

S. E. Baldwin is made manager of public relations for Willard Storage Battery and **D. M. Allgood** succeeds him as director of merchandising.

Ralph S. Pelton of the Schenectady Works Laboratory, G.E., submitted two prize-winning papers in a contest sponsored by the American Welding Society.

Let's go EXPLORING!



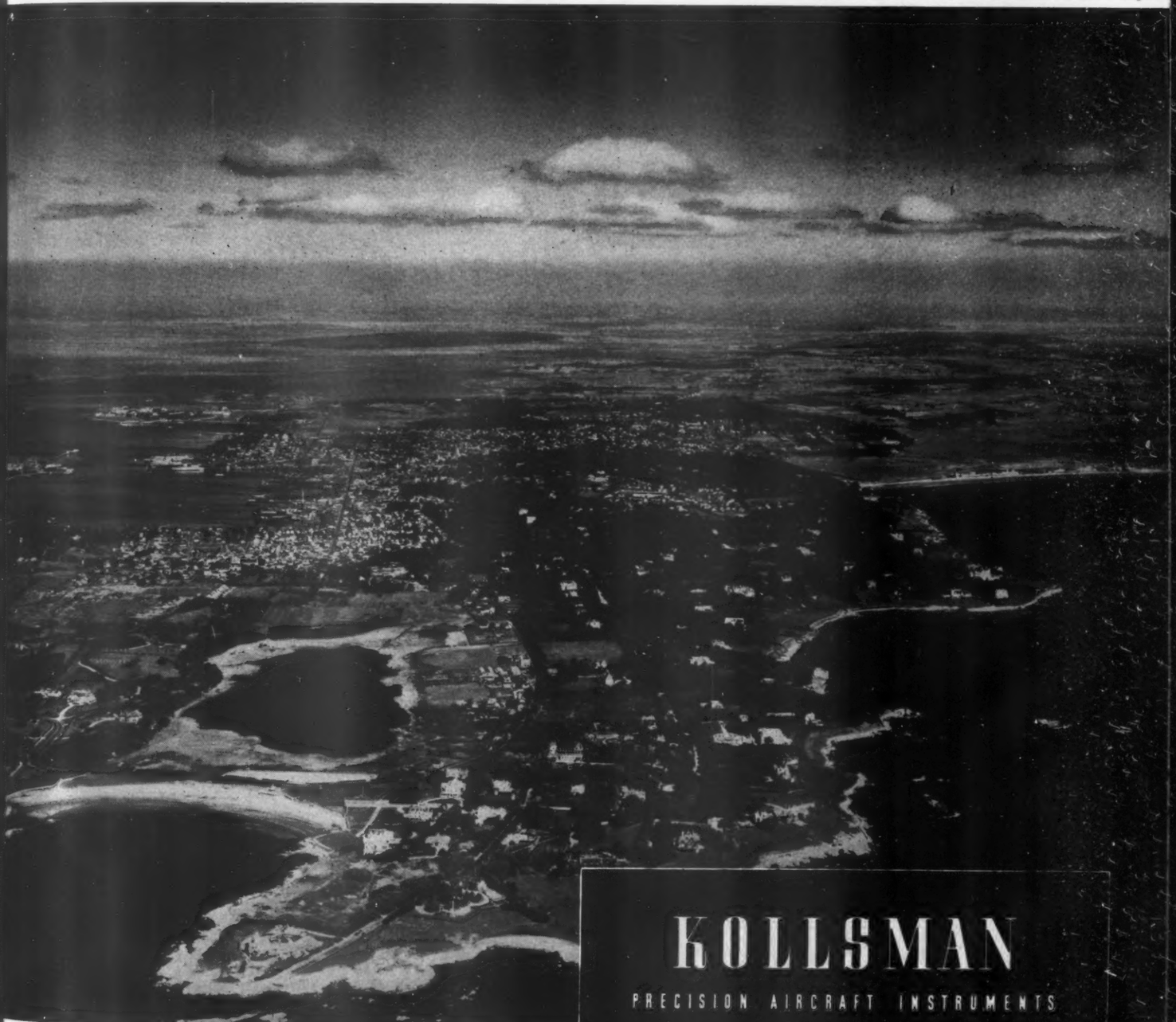
Remember how those words set your blood a-tingle when you were a kid?

Now that you're flying—recapture that thrill! *Don't* let weather keep you tethered to your airport. Get a panel of Kollsman Precision Aircraft Instruments, learn how to use them, and you *can* "go exploring."

For now the whole wide sky is yours to roam—instead of just the creek you knew at home. You can wander at will with the new Kollsman Direction Indicator. Its dial is just like that on your chart—so easy to follow.

Fill the thermos! Lock up the house! Where will you be at sundown? Over the horizon and far away. There's *adventure* ahead—with Kollsman!

Newport, Rhode Island, from an American Airlines Transport



☆ Kollsman production and research facilities today are devoted primarily to National Defense. For years Kollsman has been supplying Precision Aircraft Instruments to the United States Government Air Services, leading manufacturers and the major Airlines of the world. *Above:* a Kollsman-equipt Grumman G-21 Amphibian.

IT PAYS TO FLY

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U. S. Defense Job To GHQ Air Force

War Department announced that organization, training, and operation of air defense in continental U.S. in peacetime, as well as organization and training for task forces, are responsibilities of the Commanding General GHQ Air Force. There has been an air defense command under Maj. Gen. James E. Chaney, headquartered at Mitchel Field, New York, since December 1939. This included coordinated control of some anti-aircraft units, squadrons of pursuit planes, and units of aircraft warning service of the Signal communications.

Army, Navy, Maintain Planned Cadet Quotas

Despite shortened training courses and step-up in recruiting schedules, quotas for Army and Navy flying cadets still are being met without having to reduce their present standards of eligibility.

Air Corps program originally called for training 2,300 flying cadets a year, but was revised upwards, first to 7,000 and then to 12,000. Training schedules will meet the 12,000 quota, the Army believes.

The Navy had a similar increase of program from 3,059 pilots on active duty July 1, 1940, to a present goal of 15,000. This means that 1,000 young men a month can enter training.

The Navy output should increase materially with opening of its third pilot training center at Corpus Christi in March to augment training activities now going on at Pensacola and Jacksonville. To further accelerate output of pilots, the Navy has cut its normal course of the training centers from twelve or thirteen months to an intensified eight months' course.

Another feature of both Army and Navy pilot training activities is the increasing reliance being placed on the CAA Civilian Pilot Training Program. Two hundred CPT graduates are now being fed into the armed services per month.

Two Beechcrafts Tested

Beech Airplane Co.'s all-metal low-wing training monoplane, designated AT-7 by the Army, is undergoing tests at Wright Field. It is the first airplane procured solely for training student navigators. Is equipped with a chart table, periodic compass, a stabilized drift sight for each of three students and a celestial navigation dome for sextant readings. The C-45A, a light transport manufactured by Beechcraft, essentially the same as the AT-7, also is being tested. It is different in that it is fitted for a crew of two and four passengers. Removable panels in the floor and cabin door permit the use of vertical and oblique cameras.

Bombing From 40,000 ft.

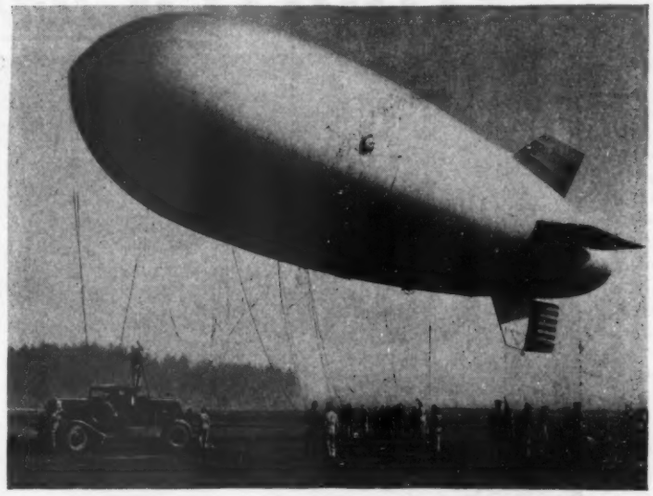
Before the war is over, long-range bombers with supercharged cabins may be operated with little fear of attack at 40,000 ft., D. W. Tomlinson, famed high-altitude flyer, recently told a California meeting of the Society of Automotive Engineers. He said the adaptation of pressurized cabins to bombers is not too difficult. Only that portion of the fuselage containing the bombardier, flight crew and adjacent rest space for the remainder of the crew need be pressurized, he explained.

Because of the difficulty of sighting aircraft in the clear weather above 30,000 ft., interception by pursuit planes will be almost impossible, Tomlinson asserted. But even if this does occur, he added, the pursuits would be almost impotent unless they, too, had pressurized equipment. To pressurize the cockpit of a fighter would handicap its performance to a much greater extent than in the case of a bomber.

This would leave bombers virtually free to operate from the upper air in daylight. They would have the advantage of almost continuously clear weather and could navigate by celestial observation. This would permit them to make a long and accurate bombing approach and would be compensation for their greater distance from the target, he said.

Attacking on Runways

RAF is trying a new method of night fighting. Fighters trace enemy bombers back to their bases and attack them as they land. Attackers hover around until the German ground staff lights flare paths which guide bombers to runways. Then they strew bombs on the runway in front of the alighting Nazis. It is difficult for RAF to claim victories because the darkness and the speed of the getaway hamper the observation of damage.



Wide World

TRAINING IN BARRAGE BALLOON TACTICS. Men of the 3rd Barrage Balloon Squadron at Ft. Lewis, Wash., send up an observation balloon without the motorized gondola on a practice ascension. Not having a real barrage balloon, Squadron must practice on this until real equipment arrives.

Aqui Se Habla Espanol

"Here Spanish is spoken." That sign goes on the Air Corps from now on. Because they have to travel more and more in Latin America, the War Department wants officers of the Air Corps, as well as those in the federalized National Guard, to learn Spanish. A program to give them instructions in the language has been announced. Classes are being arranged in troop schools and limited funds will be provided later for text books, phonograph records, etc., but there are no funds as yet to hire instructors.

"—and Four to Go"

The 501st Parachute Battalion of Ft. Benning, Ga., is scheduled to complete its course of training by the end of March and stage what might be termed "graduation exercises" consisting of successive mass jumps, company by company. This spectacular event will climax a series of actual jumps in which the personnel of the battalion, 450 strong, has been bailing out from various altitudes, individually to start with, and then in threes and in squads and larger contingents.

In the mass jump, they will be garbed in their distinctive one-piece uniforms of olive drab. The material is heavy but permits maximum free movement. Zippered pockets are provided for weapons, grenades, tools. The reinforced leather boots have inner soles of sponge rubber to absorb some of the shock of hard landing.

Air Corps Accidents

Proficiency of Air Corps personnel and condition of equipment is not measured by the number of accidents but by the rate. Army flew 900,000 hours in 1940, compared with 77,000 in 1921; number of accidents in 1940 far lower. Because ships carry more men than formerly, each accident brings more fatalities, is more conspicuous.

Eighty percent of mishaps of all kinds are caused by personnel errors; 14% mechanical defects or failures; 6% miscellaneous. Experienced pilots have far less accidents, but the lowest rate is among students supervised in schools.

Winner Take All

Senate Naval Affairs Committee is considering a bill under which captured aircraft would be considered as much prizes of war as captured vessels or ships. The measure, introduced by Senator David I. Walsh, chairman, at request of the Navy Department, also amends existing laws so as to include the pilot.

LIGHTER *more* STABLE PARTS for AEROPLANES

THE rapidly growing use of machined parts of Formica in propellers and planes, is due to the fact that the material weighs only half as much as aluminum; is mechanically strong and extremely stable in dimensions under changes in temperature and humidity.

For many years Formica pulleys and fairlead bushings have been used on most American planes taking to the air, and the performance of the material for such uses has been unusually satisfactory. It was natural, therefore, that engineers should seek new uses for so dependable a material.

The facilities of the Formica Insulation Company for sheets, tubes, rods or machined and molded parts of laminated material are as great as any in the industry. For years it has served many leading units in aviation. Send your blue prints for quotations.

The Formica Insulation Co., 4628 Spring Grove Ave., Cincinnati, Ohio

FORMICA

New Priority Regulations Improve Handling of Raw Materials and Finished Goods

Washington (AVIATION Bureau)—After months of near-chaos the priority system is now assuming fairly definite shape. Regulations have been issued to take the place of the set-up announced and then immediately cancelled last year. A pattern for handling raw materials has been established, described elsewhere in this issue, and as we go to press aluminum, magnesium, nickel, and neoprene (artificial rubber) are included in it. Machine tool makers have been ordered to deliver tools only in accordance with priority ratings. This should materially ease the problems of aircraft manufacturers, who have sometimes found themselves at a disadvantage as against old established customers.

Behind the changed tempo is the fact that priority is no longer a nasty word. The euphemisms of "voluntary cooperation" have been dropped, and ratings are frankly mandatory. Along with this is the tendency, whenever a commodity is scarce, to see that all defense users get appropriate priority ratings instead of leaving proper distribution to the patriotism and wisdom of the supplier.

The new priority regulations split the priority system into two parts. On the one hand is the "automatic" system—the part that can be reduced to rules and formulas. This is administered by the Army and Navy Munitions Board, acting as agent for the Priorities Division of OPM. On the other side is the realm where no simple formulas apply, where each case must be handled on its merits. This is handled directly by Priorities Division.

Foundation of the automatic system is the so called "critical list." This is a list of scarce fabricated and semi-fabricated military items, ranging from aluminum forgings to battleships. It includes no raw materials. Whenever an order is issued on an item on the list by the Army, Navy, Coast Guard, Maritime Commission, Coast and Geodetic Survey, or National Advisory Committee for Aeronautics, it is automatically granted a priority rating by the Munitions Board. What rating the order gets depends partly on the immediate strategic circumstances but is based, in general, on a formula assigning certain ratings to certain classes of finished goods. Thus orders for .50 calibre machine guns rate A-1-b, orders for airplanes A-1-d.

The automatic system extends also to the first subcontract. When a manufacturer holding a prime contract with a rating from the Munitions Board issues a subcontract for an item on the critical list, he may extend to the subcontract the rating of his prime contract. He follows the now familiar procedure of filling out a form and getting it countersigned by the procurement officer or inspector in charge of his contract. The rating cannot be extended automatically by the subcontractor to his subcontracts.

All other aspects of the priority situation are handled on a case-by-case basis by the Priorities Division itself. This includes all raw material priorities, all ratings on subcontracts after the first one, governmental orders, for items not on the priority list, ratings on non-governmental orders, including British orders. By far the largest number of ratings to date fall into the automatic system; they are numbered in thousands, while Priorities Division has issued about 1,500.

Aluminum and Magnesium Rigidly Controlled

Washington (AVIATION Bureau): One of the most quickly exposed mistakes of the defense program to date was the optimistic attitude on aluminum supply taken last year by then raw materials commissioner Stettinius. Shortages of aluminum castings and rolled aluminum were developing even then, and subsequent increases in fabricating capacity were unable to eliminate the shortage but did succeed in March in producing a shortage of aluminum ingot.

Result of the shortage has been that mandatory priority ratings are now applied to all defense orders for magnesium, virgin aluminum, and fabricated aluminum. These orders are absorbing all and more of the available supply, so non-defense users are thrown onto the scrap market. To avoid a wild scramble for scrap metal, the Priorities Division is allocating the product of secondary smelters and maximum prices have been set for scrap.

Scrap from airplane plants is handled in two ways. Segregated strong scrap is returned to Alcoa for remelting. Mixed scrap is being sold to scrap dealers.

Control is also being imposed on the inventories maintained by plane producers. Some of them were accumulating stocks for as much as a year's operations. Defense officials feel that a six-week inventory is enough for almost anyone. As we go to press no decision has been reached as to whether to recapture excessive inventories.

In general the new tight controls should prove helpful to most plane producers, since the effect is to remove competition for the supply. Hard hit however are the light plane builders. At present they are not even 100 percent sure that they will be able to stay in business. Nearly all have inventories that will carry them into April, especially if pieced out with small deliveries of some items that happen to run short.

By that time some kind of decision will have been reached on the future of the industry. Almost certainly previous plans to expand output from 1940's 6,000 to 10,000 or so flivvers will have to be abandoned.

THIS BELLANCA CRUISAIR is a flying laboratory for Lycoming's new higher hp. engines. It is shown with 100 hp. model.

Production To Start In New Wright Plant

First section of Wright Aeronautical Corp.'s Cincinnati plant will start preliminary production operations this month. Construction on the 2,100,000 sq. ft. single-story building, costing $37,000,000, was begun late in 1940 when ground was broken.

At capacity production, America's largest aircraft engine factory will turn out 1,000 14-cylinder Wright Cyclones monthly and employ between 12,000 and 15,000 workers. Major unit will be the machining and assembly building, 1,640,000 sq. ft.

New Advisory Service Formed

The organization of a new advisory service for aeronautical problems was announced on Mar. 1 in New York by the G. M. & L. Henig Co. Headed by L. Henig, well known aeronautical engineer, and "Boen" Hartsinck, for many years representative of the Dutch Airlines (KLM) in the United States, the company will specialize in solving problems of the smaller manufacturers, who are receiving defense subcontracts for airplane parts and equipment, and handling purchases and technical representation for foreign users of American equipment, who are not in a position to use their own personnel.

New Aluminum Plants

New plants and facilities acquired during past year by Reynolds Metals Co. in Louisville, Ky., and Lister, Ala., will have an estimated productive capacity of 23,300,000 lb. per month of aluminum.

Assembly Lines

By Robert Colborn

Total airplane production for February was 972, about 60 less than January output. The difference is more than accounted for by the fact that February is 10 percent shorter than the previous month. Factors accounting for failure of adjusted production to rise substantially include a shortage of trainer engines which has resulted, for instance, in creating of a 60-plane glider line of basic trainers at Vultee and a model-change by Curtiss from the P-40 to the similar but more advanced P-40D.

To British empire, in January, went 419 planes, mostly combat, and 500–600 additional engines.

Consolidated has completed deliveries on its orders for the PB2Y four-engine flying boat and is now in production on the later model, PB2Y-2. Specifications are not available.

Flying Fortress production at Boeing is now concentrated on the B-17D model, which incorporates armor and leak-proof tanks and achieves, with four 1,200-hp. Wright engines, a speed "well in excess of 300 mph." Next step is the mass production model, the E, which reportedly will have cannon, and 1,700-hp. engines.

Export of Link trainers, mechanical devices in which, under a hood, a student gets all the effects of flying without leaving the ground, has been subjected to license.

Solely for navigation training is Beechcraft's twin-engine advanced trainer, the AT-7, now being Army flight tested. Has chart table, periodic compass, three stabilized drift sights, and a celestial navigation dome. Power is P & W 450-hp. engines, weight is 7,850.

Expansion program of Lockheed Aircraft is more than 90 percent completed and operations for 1941 should definitely begin to reflect expenditures as far back as the spring of 1940, Robert E. Gross, president, declared in a statement to stockholders accompanying the annual report. In all of 1940, Lockheed produced 404 airplanes, as compared with 356 in 1939 and 99 in 1938.

Whatever may be the ultimate fate of commercial plane production, which is still under Army attack, Priorities Division has no intention of cracking down on manufacture of parts, accessories, and maintenance items for the airlines, as long as the producer feels he can squeeze them in without interfering with his defense business.

Advertising for men by holders of defense contracts or recruiting labor outside the local area is opposed by OPM, which thinks it encourages unnecessary migration, high turnover, and "disturbances of established labor standards." Knudsen sent a letter to all contractors asking them to get their men through the U. S. Employment Service.

Beech Aircraft has agreed with the Machinists Union that when

PUTTING THE FINISHING TOUCHES to flotation bags used for the protection of land planes which may be forced down over water. These bags, made by the Goodyear Tire & Rubber Co. for U. S. Army and Navy aircraft, are shown prior to their final inspection and preparation for shipment to military plane manufacturers.

output of twin-engine Beechcrafts (used by Air Corps as advanced trainers, passenger, and photographic ships) reaches 20 a month, hourly rates will be raised 2½c., with another equal raise when production reaches 50. Present schedule calls for 20 in May and 50 in June.

More than a third of Lockheed and Vega employees, some 8,000 men, are enrolled in special 20-week, three-nights-a-week extension trade courses offered in the Burbank, Calif., schools.

A 36-week training course has been established in Kansas City to provide men for the government-owned North American-operated plant being built there to assemble B-25 medium bombers from parts fabricated in Detroit. Running four 6-hr. shifts, the school can handle 750 men.

CIO has named Richard Frankensteen of the Auto Workers Union to head the current organizing drive in aircraft. Walter Smethurst, who has been in charge of the West Coast campaign on a more or less autonomous basis, becomes assistant.

Biggest propeller plant yet has been put under construction just outside of Pittsburgh by Curtiss-Wright Propeller Division. It is to be in production by late summer. The new 415,000-sq.ft. plant will bring Curtiss' propeller floor space to 1,415,000. In 1938 it was 17,000.

Martin's new Plant 2, a mile and a quarter from the existing Middle River plant at Baltimore, is scheduled for completion in early summer, bringing in 1,181,000 sq.ft. of floor space. At about the same time expansion of the original Plant 1 to 2,333,000 ft. will be complete. The government-owned plant at Omaha, 1,255,000 sq.ft., is scheduled for completion in November.

United Auto Workers has been certified as bargaining agent for Vultee employees after winning an NLRB election 141 to 7.

Piper, now completing about 100 cubs a week, has instituted a flyaway delivery service using the more than 300 of its employees who are pilots. The trips are said to be mighty popular around weekends.

Taylorcraft has brought out a tandem trainer in the 65-hp. class to supplement its side-by-side models.

Pitcairn-Larsen Autogiro Co. has been organized to succeed to the business of Pitcairn Autogiro. The new company has contracts with the British for several military giros. Virgil H. Frazier is president, Agnew E. Larsen, general manager. Harold Pitcairn is a director.

Engine Production

(Continued from page 97)

to prevent creation of "glider lines" of planes without engines.

This country now is building each month more than 900 of three engines equal in performance to any production models in the world, one of which cannot be matched abroad. Pratt & Whitney is building the only 2,000-hp. engine in assembly line production. This is an air-cooled radial engine with 18 cylinders arranged in two banks. Production rate on this R-2800 started the year at 60 a month. It is scheduled to reach a peak of 350 a month by June. In August, Ford will start turning out the same engine under license and should reach 300 a month by the end of the year. At about that time, Buick will begin producing, also under license, and will reach 500 a month sometime in 1942. Thus a 1942 total of 1,150 is scheduled, apart from any further expansion that may be undertaken.

The other big air-cooled radial is made by Wright. This is a 1,700-hp. job of 14 cylinders in two rows; it has been in production longer than the P & W, and 500 a month are now being turned out. Studebaker is to start building these late this year, with an ultimate output of 500.

The big radials are being used in bombers, Navy fighters, and will be used in one Army pursuit, the Republic P-47. For most of its pursuit the Army relies on liquid cooled engines, which means for the present the Allison V-1710.

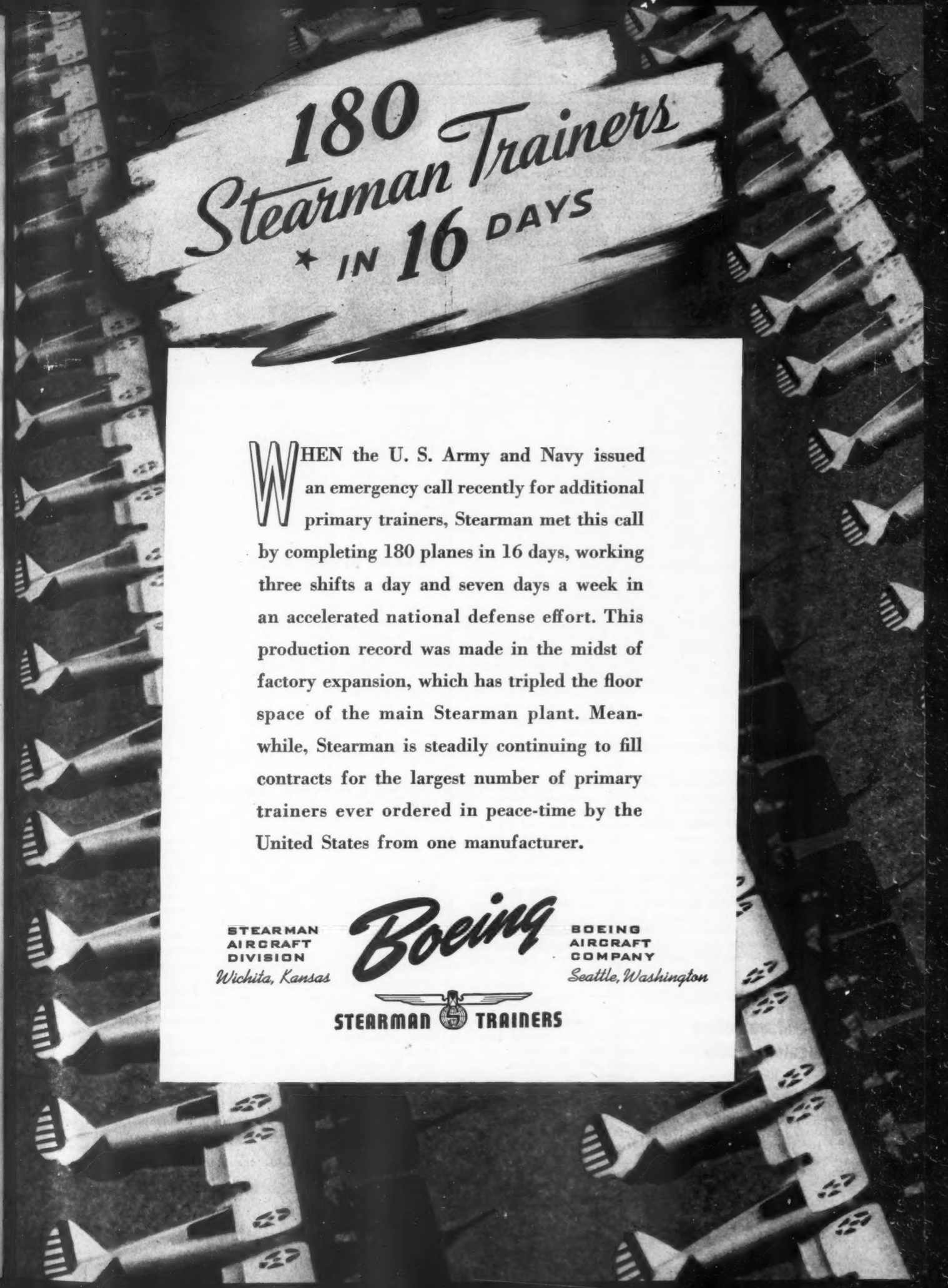
Another source of liquid-cooled engines will come in during the year. Packard will turn out the first hand-assembled units of the Rolls Royce Merlin within a few months, and will reach full production of 800 a month late in the fall. The Merlin is a British design similar generally to the Allison.

Hand-built specimens of one such engine have been flown. This is Rolls Royce's new 1,900-hp. Vulture, a 24-cylinder X engine which is essentially two Merlins on a common crankshaft. Real quantity production of this engine is believed to be at least a year away.

Moreover, Packard has not yet abandoned hope of adapting its V-12 marine engine for aircraft use. It is now in the 1,200-hp. range but it is thought that application of aircraft design features might step this up nearly 50 percent without increasing the number of cylinders.

Even farther from production than the Vulture is Allison's version of the 24-cylinder X. One such engine was hand-built last summer, but the technical problems have not yet been licked, much less production.

A possible alternative, combining air-cooling with low frontal area, is the Napier Sabre, a British design stemming from Napier's Dagger VIII. It is an air-cooled engine developing something like 2,000 hp. from 24 cylinders arranged in an H pattern, with two crankshafts geared together.



WHEN the U. S. Army and Navy issued an emergency call recently for additional primary trainers, Stearman met this call by completing 180 planes in 16 days, working three shifts a day and seven days a week in an accelerated national defense effort. This production record was made in the midst of factory expansion, which has tripled the floor space of the main Stearman plant. Meanwhile, Stearman is steadily continuing to fill contracts for the largest number of primary trainers ever ordered in peace-time by the United States from one manufacturer.

STEARMAN AIRCRAFT DIVISION
Wichita, Kansas

Boeing

BOEING AIRCRAFT COMPANY
Seattle, Washington

STEARMAN TRAINERS

On Schedule

By "Vista"

Upon his return from a survey of world traffic, H. B. Longfellow, foreign traffic manager of United Airlines, revealed that even in this war-torn world, complete circumnavigation of the globe on commercial airlines, though no longer regularly scheduled, is still possible. During his voyage Mr. Longfellow found that British Overseas Airways is maintaining her regular connection between England and Portugal, besides numerous routes in England proper; in Lisbon, connections are made with Pan American's Clippers, while the British have further lines via East Africa to Egypt, India, Burma and Malaya, where Quantas Airways takes over for the hop to Australia. From Sydney, Tasman Empire Airways provides service to New Zealand, where Pan American's flying-boats terminate their California to Auckland schedules. In addition, the Dutch KLM is still operating the Palestine to Batavia service, with a network of busy routes over the East Indian islands, including New Guinea, and an important landplane connection to Sydney, flown with DC-3s. It was the opinion of Mr. Longfellow that the end of this war would find Europe in a perfect position for opening an extensive air-network, with a concerted attempt at overseas expansion, giving strong competition to already existing lines. It is to be hoped that the importance of obtaining a strong position in the foreign air transport field is realized soon in this country, and that other lines, able to establish reliable trans-Atlantic services, are given a chance. This will give American companies a head start against the attempts of foreign, subsidized airlines, generally state-owned, to corner the market.

The expansion of German controlled airlines in Latin America is beginning to take on alarming proportions, apparently without much official attention from this country. A German controlled airline in Brazil recently obtained two of the latest Lockheed Lodestars, according to reports, while one transport plane and much spare equipment arrived on a blockade running German freighter recently, destined to the Condor line. A recent excellent survey by *Fortune* clearly revealed that the network of German airlines in South America rivals Pan American's service, and their value as a source of espionage cannot be underestimated. A proposal was recently made that enough money be appropriated by Congress to buy up all Axis controlled airlines in this hemisphere, placing these lines under American management.

An announcement from Berlin recently said that the German Airways now connect ten "foreign" countries, while 15 others can also be reached by air. Four motored Junkers are reported on all routes, giving service to most of Europe, including all Balkan countries, Portugal and Russia.

Trans-Atlantic service will be opened sometime in May by a subsidiary of British Overseas Airways, reportedly with Short "C" class flying boats. In addition, extensive ferrying operations will be undertaken for the pilots flying over military aircraft from Canada to England. Reliable information indicates that some of the four-engined Consolidated B-24s will be converted into pilot-ferries, probably starting the first fairly regular landplane service with passengers over the ocean, in this case some 1,800 miles of open sea.

Aircraft Manufacture At Bangalore, India

British Indian reports indicate the establishment of the Indian Aircraft Co. Ltd. at Bangalore, sponsored by S. W. Hirachand, motor magnate, and under the management of Wm. D. Pawley, formerly manager of the Central Aircraft Co. in China. American experts will get operations started, but it is hoped that eventually all employees will be Indian.

During the war, production will concentrate on fighters and bombers on a 24-hr. basis; eventually commercial and sports-aircraft will be built, for which a ready market is expected in British India proper.

It is stressed in reports that all necessary raw materials are available within the state.

British Combine

A Bristol Bombay troop transport used by the British for carrying personnel in England. Recently when a Canadian RAF squadron moved from one flying field to another, pilots flew their own Hurricanes, but mechanics and all operations personnel and equipment moved in these 24-place transports.

Canadian Aviation News

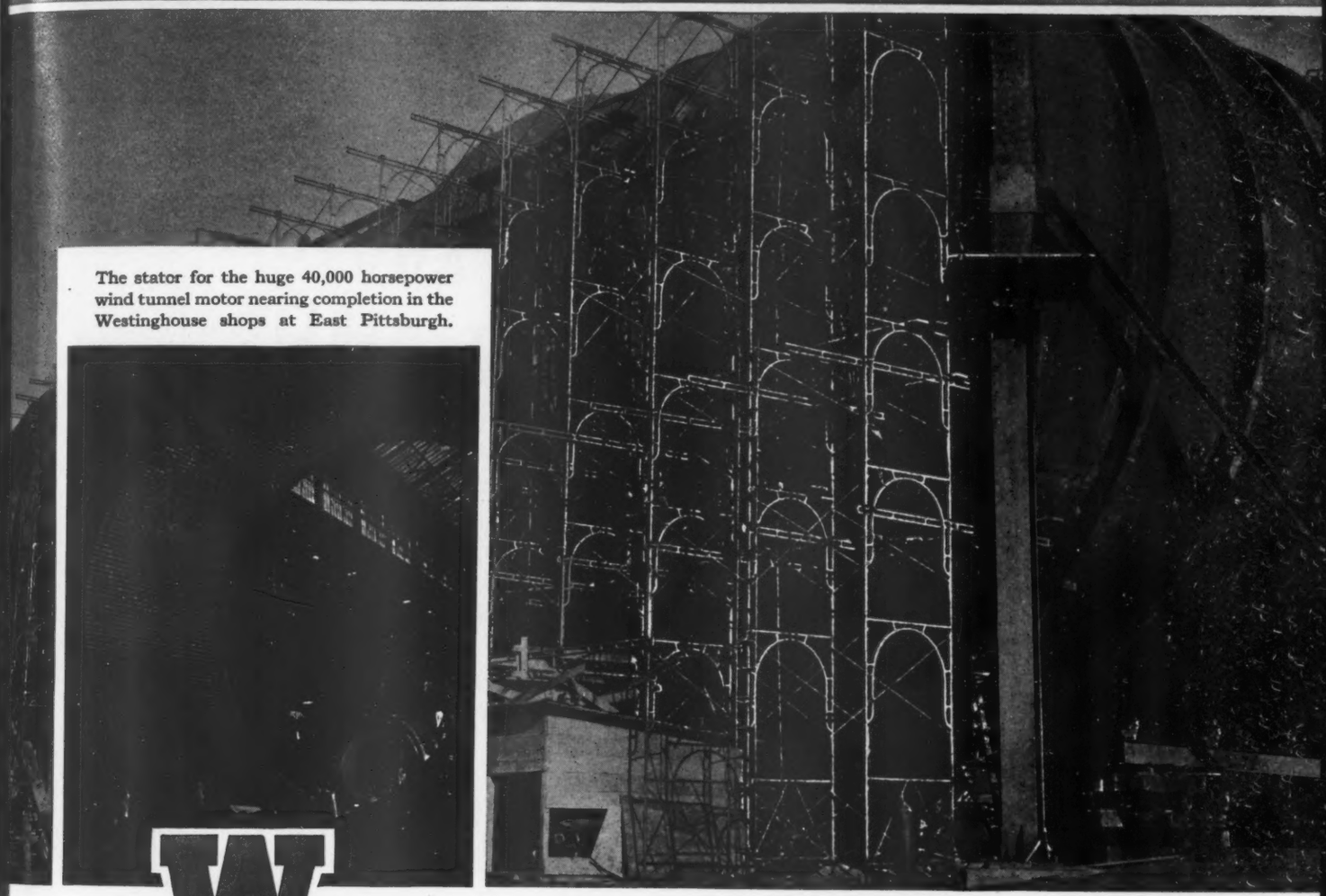
By James Montagnes

The final quarterly report of the Civil Aviation Branch of the Department of Transport, Ottawa, shows that at end of 1940 there were 825 private pilots licensed, 128 commercial pilots, 249 limited commercial pilots, 152 transport pilots, 822 air engineers, and 42 airport traffic control officers. At the same time there were 63 private aircraft licensed, 410 commercial aircraft and 97 airports.

The report states that on the trans-Canada airway from Vancouver on the Pacific to Moncton on the Atlantic Coast, intermediate airports are lighted for night flying at approximately 100-mile intervals. Meteorological services provide weather maps four times daily, and district forecasts for the ensuing six hours. There are now in operation 42 radio range stations at approximately 100-mile intervals, except in the mountain regions where closer spacing is necessary. Feeder routes to the government-owned Trans-Canada Air Lines are now operating daily or more frequently by private operators from Moncton to Halifax, Saint John and Charlottetown; between Vancouver and Victoria; from Regina to Moose Jaw, Saskatoon, Prince Albert and North Battleford. Canadian Airways Ltd. operates the first two services, Prairie Airways Ltd., the third service.

Twenty-one flying clubs operated during 1940, giving instruction to 333 members and flying a total of 43,085 hr., biggest total since the clubs began operating in 1928. The clubs trained 190 private pilots and 59 commercial pilots, used 42 aircraft, had a total membership of 1,331. What has happened to the clubs since the start of the war is shown by the annual report of the Toronto Flying Club, which rolled up the largest flying time in 1940, a total of 5,644 hr. At the annual meeting president C. E. French reported that 60 members had signed up for active service, that six had already made the supreme sacrifice. The clubhouse had been turned over as living quarters for the elementary training of pilots for the Norwegian army and naval air forces. The club had set up an elementary training school at a nearby government airport as part of the British Commonwealth Air Training Plan. Figures on operations of this school could not be given. A former president, Wing Commander T. R. Loudon, is in charge of the Wireless Training School at Montreal in connection with the British Commonwealth Training Plan.

Hawker Hurricanes were being turned out at the rate of 15 per week at a Ft. William, Ont., factory, it was announced in Parliament on Feb. 26, by Munitions and Supply Minister C. D. Howe. (An order for 600 of these planes was given the Canadian Car & Foundry Co., Ft. William, last August.)



The stator for the huge 40,000 horsepower wind tunnel motor nearing completion in the Westinghouse shops at East Pittsburgh.

World's largest motor powers Army wind tunnel fan

Man-made hurricanes of 400 miles per hour in the new Army wind tunnel, Dayton, Ohio, will facilitate airplane tests. Westinghouse is now completing the world's largest wound-rotor motor for this wind tunnel—a 40,000 horsepower motor that will drive two 40-foot fans. Speed can be varied from 37 to 297 revolutions per minute. Nearly two stories high, the motor will require 85,000 cubic feet of air per minute to cool it when operating at top speed.

Construction of this huge motor is evidence of Westinghouse Engineers' ability to build equipment that meets the exacting needs of the aviation industry. You will find Westinghouse developments in every phase of the industry—precision motors and control for parts manufacturers, complete airport lighting, radio range equipment, instruments, and scores of others.

Westinghouse offers you the latest developments in electrical equipment. You'll find it worth-while to call our local office for every electrical need.

WESTINGHOUSE ELECTRIC & MFG. COMPANY, EAST PITTSBURGH, PA.

LOOK TO WESTINGHOUSE FOR LATEST DEVELOPMENTS IN THIS AVIATION EQUIPMENT

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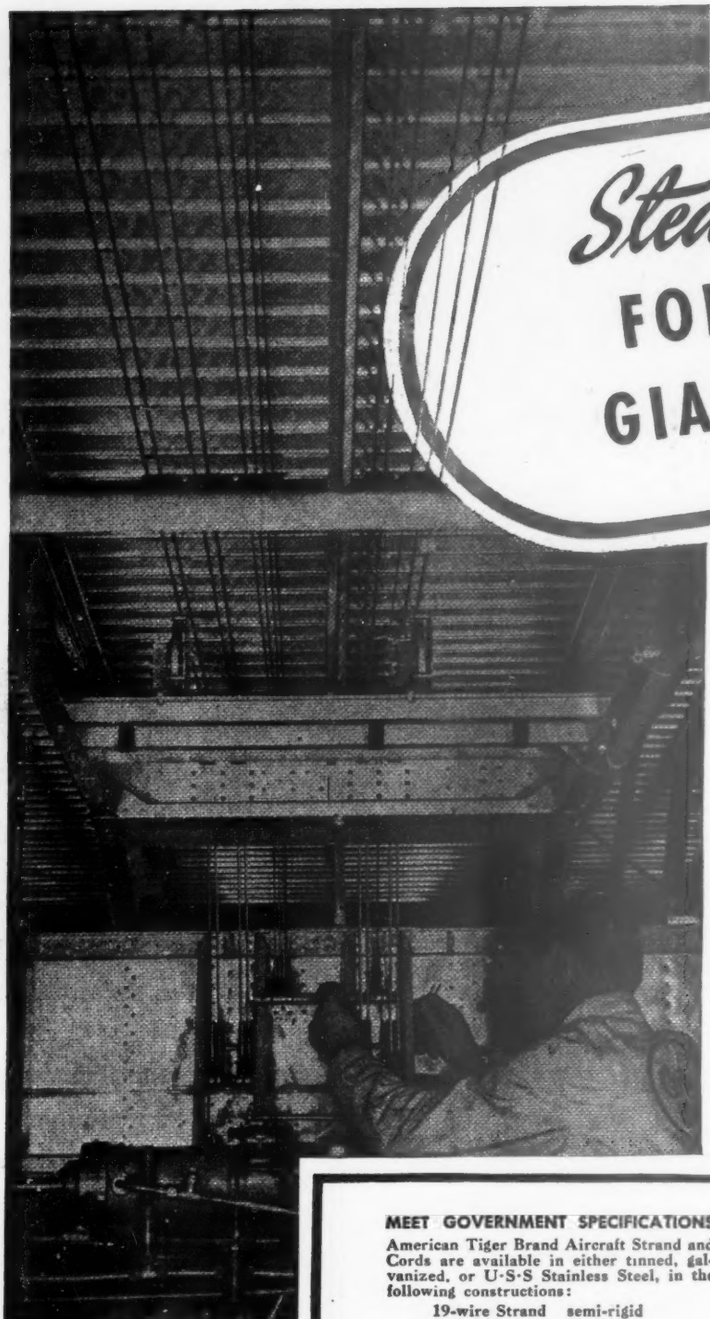
TIME-SAVER FOR THE AVIATION INDUSTRY



Steady Nerves FOR ANOTHER GIANT AIRLINER

HERE are control cables that are engineered and produced with the same precision as both power plant and structure of the newest aircraft. Only the finest steels go into their manufacture. Every wire of every cable is cold-drawn to high tensile strength through accurate dies, under the direction of men who specialize in the making of control cables that are as sound and trustworthy as modern science can make them.

That's why so many aircraft designers and builders specify American Tiger Brand Strand and Cords. That's why you'll find them used in America's finest ships.

***This engineer** is making final adjustments on cables controlling ailerons, elevators, wing flaps, and rudders. In this ship, as in other famous commercial, private, and service aircraft, all control cable is of American Tiger Brand Aircraft Strand and Cords.*

MEET GOVERNMENT SPECIFICATIONS

American Tiger Brand Aircraft Strand and Cords are available in either tinned, galvanized, or U·S·S Stainless Steel, in the following constructions:

19-wire Strand	semi-rigid
7 x 7 Cord	flexible
7 x 19 Cord	extra-flexible

These products offer superior strength, excellent fatigue resistance, and minimum stretch. They are fully in accord with the latest U. S. Army and Navy specifications.

AMERICAN *Tiger Brand* **AIRCRAFT STRAND AND CORDS**

AMERICAN STEEL & WIRE COMPANY

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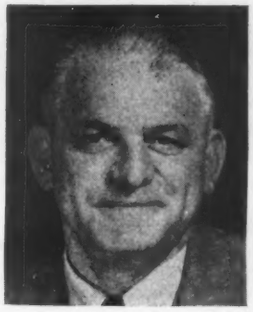
UNITED STATES STEEL



East goes west and west comes east in North American Aviation's most recent reassignment of executive personnel. ALEXANDER T. BURTON (l.) joined the company in 1937, and in late 1940 was appointed division manager of the Dallas unit. He now goes to Washington as North American's representative. LELAND R. TAYLOR (c.), Washington representative since 1939, returns to Inglewood to assume a new position as executive staff assistant. E. J. RIVERS (r.), who was appointed factory manager of North American Aviation of Texas in 1940, will head operations at the Dallas plant. Announcement was made by J. H. KINDELBERGER, president of North American Aviation.

The new special assistant to the Secretary of War for Air, ROBERT A. LOVETT, was Lt. Commander, U. S. N. Air Force during World War. He is a partner of Brown Bros. Harriman & Co.

Active for the past year in developing a new line of radio equipment being manufactured by Air Associates, W. D. VAN DYKE is now named general manager of the new radio division.

GORDON ISRAEL (above) is elected vice pres., engineering, for Howard Aircraft. He is co-designer of the Howard. B. D. DE WEESE is pres., and C. W. FREITAG, vice pres., sales.

Hayes Mfg. Corp.'s new director and president, RENSSELAER W. CLARK, was v.p. of United Aircraft from 1935 to 1940; became associated with the National Defense Commission in 1940.

Southwest Feeder Airlines' new president and general manager, THOMAS O. HARDIN, has had many years of airline experience, latterly as vice president of TWA and chairman of CAA's Safety Board.

In 1914 LOUIS F. MALKOVSKY joined Sperry Gyroscope Co. as tool maker, subsequently worked in every department, and is now elected vice president in charge of production on the entire line.

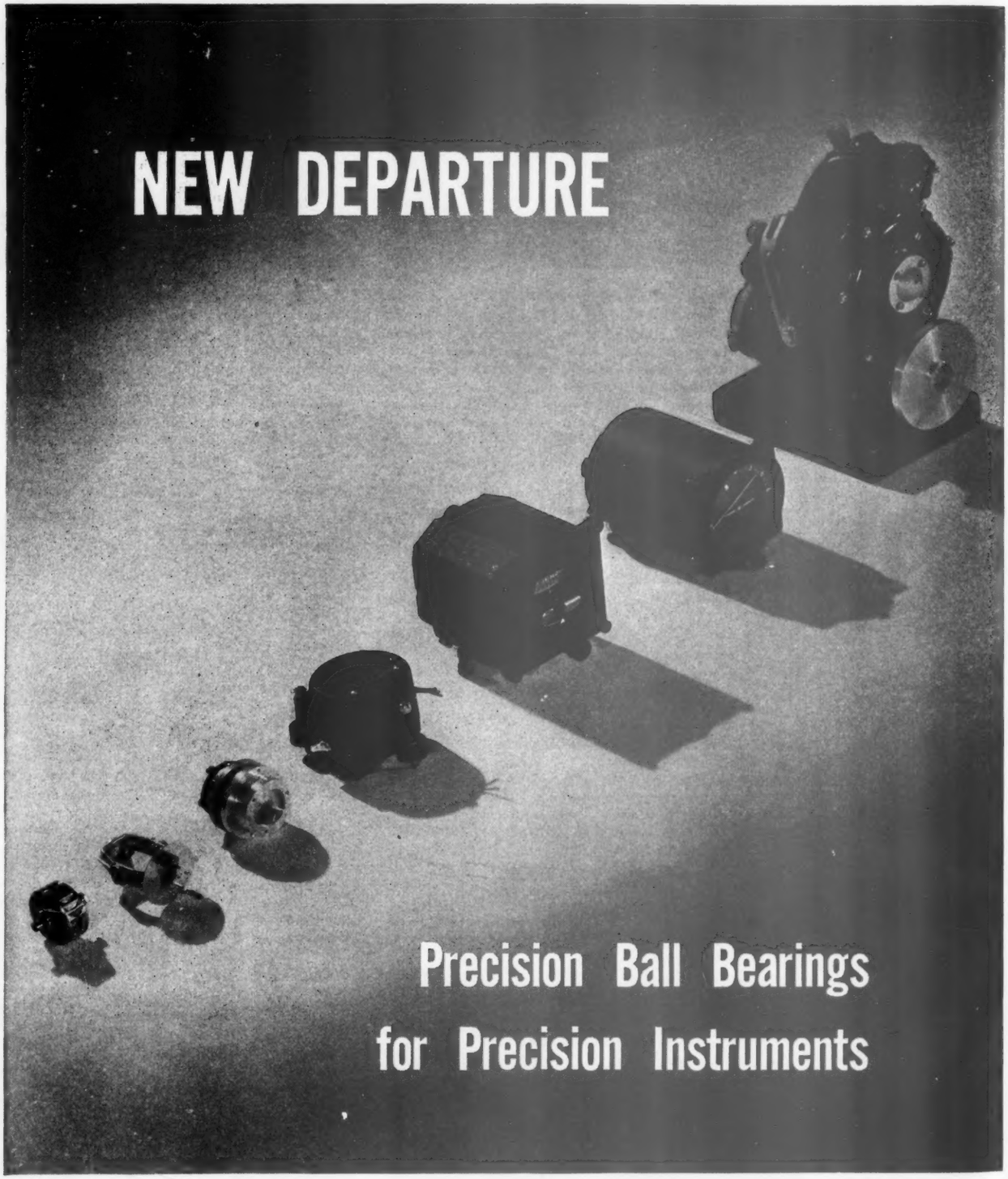
RONALD S. GALL terminates eleven years as public relations manager for Wright Aeronautical to fill the same office for Brewster Aeronautical. He was founder of Wright Co.'s "Trade Winds."

New chief engineer of Adel Precision Products Corp., LYNN REYNOLDS, held various government aviation posts during World War; since 1932 was metallurgist at Worthington Pump.

Veteran flyer ORVILLE E. MOHLER, for past year sales manager of Menasco Mfg. Co., is elected vice president in charge of sales. He is credited with greatly expanding Menasco distribution.

A former newspaper, advertising, and public relations man, PHILIP GUSTAFSON, succeeds Ronald Gall as manager of public relations for all of the Wright Aeronautical Corporation plants.

Expansion of Lear Avia into the manufacture of new accessories has resulted in the appointment of Dr. V. A. HOOVER (l.) as manager of the new Motor Division, and RICHARD M. MOCK as manager of the new Equipment Division. Dr. Hoover, an electrical engineer, has been with Lear since October, 1940. Mr. Mock's extensive aeronautical background includes that of onetime technical editor of "Aviation."



● Accuracy to microscopic tolerances—extreme sensitivity by elimination of friction and wear—reliability assured by over fifty years of experience—these are vital features obtained by America's instrument makers through the use of New Departure Precision ball bearings.

NEW DEPARTURE, DIVISION GENERAL MOTORS CORPORATION, BRISTOL, CONNECTICUT

World's largest manufacturer of precision instrument bearings

2991

Safety Council Convention

Accident prevention in the manufacture, maintenance and operation of military, commercial and civil aircraft will be the theme at the Aeronautical Section of the 12th Annual Safety Convention and Exposition to be held at the Hotel Pennsylvania, New York City, April 22–25.

Under the direction of the Greater New York Safety Council, the convention will be a four-day affair this year to permit inclusion of all national defense phases of safety programs which confront safety engineers and departments of accident prevention. The aviation sessions are sponsored by the Aviation Section of the National Safety Council, and will occupy the first day of the convention, April 22.

Grove Webster, chief, Private Flyers Section, CAB, will preside at the morning session which will be largely devoted to safety problems of the private flyer. The afternoon session will be presided over by Major R. W. Schroeder, vice president, United Airlines. In the session on Fire Defense, members of the New York Fire Department, who spent several months in London working with the British fire fighters, will recount their experiences and make specific recommendations for American industrial defense against incendiary bombs.

Black Light

Instrument illumination that is not only easy on the pilot's eyes, but which also leaves the cockpit in total darkness, has been perfected by the Army Air Corps in conjunction with engineers of Electronic Laboratories, Indianapolis, Ind. Called "black light," the new illumination has now been adopted as standard by the Materiel Division and required on equipment of the Air Corps.

The seeming phenomena is accomplished by use of radio active paint on the instruments which are subjected to rays from filtered fluorescent lamps. Maps and charts are also being chemically treated so that they glow under the rays of these lamps. A near-ultra violet filter permits the passage of only the harmless beams of "light" which cause the paint to glow. To operate the fluorescent lamps 110 vAC is required and, since planes normally offer either 12 or 24 vDC, a power converter is used to supply the desired current. Standard converters now under construction by Electronic permit the use of from one to eight lamps depending on the amount of light required. Lamps are supplied mounted on fixed brackets or with a flexible gooseneck, and all converters provide a 3-volt outlet for use where a normal white light is desired in conjunction with the fluorescent system.

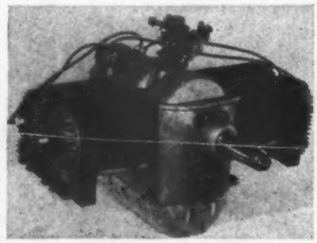
New Aircraft Engine

Information has come in recently about a new aircraft engine which is said to utilize the heat of the motor to burn low octane gasoline giving the efficiency of high octane fuel.

Developed by Victor J. Caron, 47 Willie St., Haverhill, Mass., the engine is a four-cylinder, double opposed, four-cycle aircooled type. New type of inner in-take manifold is claimed to be so designed as to eliminate all condensation at all temperatures, and which vaporizes low grade gasoline into high explosive. Crank shaft is 2 in. in diameter and bearings are 2x1¼ in., and are interchangeable with all main and rod bearings. Having only two throws for the four cylinders, a lot of metal is said to be eliminated, making a stiff and stubby yet very light crank shaft.

Specifications are as follows: bore and stroke, 3½x4 in.; piston displacement, 154.4; compression ratio, 6.5 to 1; weight (with accessories) 136 lb., and is said to develop 75 hp. at 2,000 r.p.m.

"BLACK LIGHT" in an Army bomber. Top, showing cockpit using standard white light for illuminating instruments and, below, the same cockpit with "black light" in use. Note complete lack of any glare.



A NOVEL ENGINE said to use low grade gasoline giving the efficiency of high octane fuel, the Caron 75 hp. aircooled motor has four double-opposed cylinders.

Directional Antenna For Civilian Planes

A new directional loop antenna for civilian airplanes which makes radio direction finding possible with a conventional aircraft receiver, has been announced by the Aviation Radio Section of RCA.

Two models are designated, AVA-56 and AVA-56A. The former has the loop turning control at the end of a 10 or 30 in. shaft; the other provides remote turning control by means of a cable from the instrument board or from some other convenient location.

Electrostatic shielding and balanced windings of the loop are said to materially reduce precipitation static and allow clearer reception of weak signals under unfavorable conditions.

Although designed for use with RCA aviation radio receivers, the antenna can also be used with any other receiver having an adequate sensitivity, and whole input circuits can be trimmed to match the electrical characteristics of a transformer.

Templates in Five Minutes

Work templates can now be reproduced in 5 min. by an electrolytic transfer process developed by Lockheed laboratories, Burbank, Calif., which is being made available to the industry.

Said to be faster and more economical than the photo-loft-template process, the new method is simple and the materials used are standard in most plants. A master layout is scribed from an engineer's drawing on a galvanized iron sheet about .040 in. thick, one face of which has been prepared with a special coating of insulating paint. Layout thus formed is sprayed with a transfer solution and the wetted surface is pressed into firm and uniform contact with a copy plate in a specially built press. An electric current passing between the two plates results in the layout of the master plate being transferred instantly to the copy plate. Given a thin protective coating, the copy plate is then ready for immediate use by the template cutters. Total time required, from the moment the copy plate is placed in the press with the master plate until it is washed, dried and ready for the template department, is not more than 5 min.

The press now being used at Lockheed will accommodate 48x 144 in. plates and is estimated to have a daily layout copying capacity equivalent to 500 man-hours of manual copying. Size of layout is limited only by the size of the press employed, and the total cost, including labor and materials, has been found to be less than 10c. per sq.ft.

Air System Has Fifth Accident Near Atlanta Company, Congress, and CAA Start Inquiries

Washington (AVIATION Bureau)—On the night of Feb. 26, the airline system's fifth serious accident, since the 17-month "safety" period, occurred on Eastern Air Lines in a midnight let-down through overcast for a landing at Atlanta, Ga. Eight people were injured and eight died. Capt. E. V. Rickenbacker, World War fighting pilot and president of EAL, had a difficult recuperation in an Atlanta hospital.

Several aspects of this accident caused Congress to take special interest in it. For one thing, Senator Pat McCarran, chief author of the Civil Aeronautics Act, has been blaming the President's reorganization of the Authority for all the accidents, since the crash at Lovettsville. Another point of interest to Congress was the death, in the EAL crash, of William D. Byron, Representative from Maryland. A third consideration was the total of 55 airline fatalities since the famous 17-month period. Still another was the statement made by the CAB in its report on the Salt Lake accident still fresh in legislative memories, that two causes were the failure of the Salt Lake federal radio range, and a defection of duty by federal employees who should have monitored the range.

Technical observers doubted whether the political reorganization of CAA had any connection with the airline failures. The original Air Safety Board was abolished, but its functions remained intact within the CAB, with even broader powers than the ASB had. On the other hand, there are the five accidents spread on the record, as against the much-vaunted 17 months of no accidents whatever under the original CAA. In the public mind it's a strong argument.

Both Houses of Congress, at this writing, were appointing committees to conduct an investigation of the airline accidents. It looked as if long-drawn testimony would be taken on many mechanical and economic phases of the industry. It appeared doubtful if much that is new would be brought out.

Unofficially, government interests were considering the general theory that as the airlines improve their flight technique, they use it up in trying to complete more schedules, rather than saving it as a safety margin. And, since the airlines are under CAA supervision, it was deduced that CAA is responsible for permitting the lines to crowd the weather, if they do. What the operators themselves would say about this was waiting upon the inquiry.

So much concerned were the public and Congress over the situation that the National Aeronautic Assn. saw fit to take a stand for improvement, adopting a helpful rather than a critical attitude, calling for the cooperation of the airlines and the government, and offering an eight-point safety program of its own.

A few days after the accident, CAB issued a temporary order raising by 200 ft. the minimum ceilings which must prevail at system airports for landings and takeoffs. Both the company and the Authority started investigations immediately.

Northwest to Alaska

Not long ago Mayor Fiorello La Guardia of New York, and member of the US-Canadian defense board, and Sen Scott Lucas, of Illinois, made a joint statement to the effect that an airline, direct from Chicago to Alaska, would be an astute defense move.

The next step was an application by Northwest Airlines for a route certificate from the twin cities of Minneapolis and St. Paul to Fairbanks, Alaska, a distance of 2,520 miles, which, the company states, is 800 miles shorter than the present airway from the Atlantic Coast through Seattle. Hearings had not yet been scheduled at this writing.

Export Airlines Waits On Government Action

Washington (AVIATION Bureau) — Senate hearings were about to start as this was written on re-instatement of the $1,300,000 appropriation for Atlantic mail pay for American Export Airlines, which holds a certificate on New York-Lisbon.

Meanwhile AEA's application for purchase of the Central American TACA system, on which it holds an option, is pending before CAB, and hearings had not been set at this writing. A hearing on the application for a route certificate from New Orleans to Cristobal, Canal Zone, was set for April 15.

PCA To Birmingham

Pennsylvania - Central Airlines inaugurated passenger service between Pittsburgh and Birmingham, via Charleston, W. Va., Knoxville and Chattanooga, on March 6. Cargo service has been in effect over the new 663-mile airway since Feb. 26.

TWA New Antenna

A new airline radio antenna which can be used on several frequencies simultaneously has been patented by Howard K. Morgan, superintendent of communications for Transcontinental & Western Air. The device replaces complicated and expensive switches or multiplicity of antennas. The new antenna is designed for multiple use and is also very efficient on each frequency, according to the inventor. Experimental work carried on over the past three years showed the new system to be effective and interference-free when installed almost adjacent to other antennas which were disturbed by electrical noises.

Indianapolis Pick-Up

Mercury Development Corp. has applied to CAB for certificate to operate air mail and express "pick-up" service to 135 Mid-Western towns and cities in seven states, radiating out of Indianapolis.

President of the new firm is Harold L. Plummer, former assistant national adjutant of the American Legion. Amberse M. Banks, a former Army flyer and pick-up pilot for DuPont in the East, is vice president in charge of operations.

New Caribbean Schedule

Pan American Airways changed schedule March 1 to provide daily service from Brownsville to the Canal Zone and through to Port of Spain. The whole trunk line in the Caribbean has a daily run; passenger capacity is increased more than 16%.

First of PAA's new fleet of six Boeing super-clippers was lowered into launching position last month and delivery was expected about April 1; the remaining five to come at the rate of about one a month.

PAA deplores reports that the three Boeings turned over to Imperial Airways were not wanted because the Company expected to get newer models. Three more of exactly the same design have been added to PAA's order. The new ships have bigger engines, improved propellers, and bigger gas tanks than the clippers now in service.

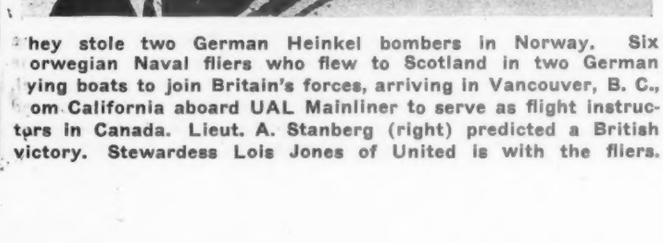
Company is taking delivery of three Lockheed Lodestars for the Alaska route; service starts about April 1, four times weekly.

CAB approved the merger of all the PAA system companies.

C & S New Service

Chicago & Southern inaugurated its newer and faster service between Houston and Chicago via Memphis the first of March with flight of the "City of Houston", new $125,000 Chicago & Southern airliner, between the terminal cities.

Night service will not be offered until the necessary aids are provided over the route by



hey stole two German Heinkel bombers in Norway. Six orwegian Naval fliers who flew to Scotland in two German ying boats to join Britain's forces, arriving in Vancouver, B. C., om California aboard UAL Mainliner to serve as flight instructors in Canada. Lieut. A. Stanberg (right) predicted a British victory. Stewardess Lois Jones of United is with the fliers.

AIR TRANSPORT INDICATOR

March 1, 1941

140.9

Which is the ratio of passenger-miles reported by the Air Transport Association for all domestic lines for February, 1941, to the figure for February, 1940. Total for the indicator has risen above the previous month's low, reversing the down trend. For the first two months of 1941 traffic stood at 128,707,002 revenue passenger miles—up 4.2 per cent over February, 1940.

See Finance page for individual companies' traffic figures.

the Federal Government. A second schedule will be inaugurated on April 27. Shreveport and Pine Bluff will be omitted as ports-of-call until pending airport improvements are completed later in the spring.

UAL Engine Run-in

United Air Lines' run-in of green and final-test Pratt & Whitney engines at the Cheyenne maintenance base does not include any military engines. United's purpose is to relieve test cells at Hartford for the benefit of the military program. Engines have been run in at Cheyenne for Continental, Inland, and other lines, including UAL of course.

Cheyenne has two engine test cells, which are capable of handling 12 engines a week; this number could be doubled by working a third shift instead of the present two. No additional test facilities were planned at this writing, either at Cheyenne or any other point on the UAL system. United did not know whether any other lines planned to follow its example. The test-stands at Cheyenne can accommodate only the 1,000 and 1,200 hp. sizes, but the engineers say that, with some modifications, they could handle units up to 2,000 hp.

Time Marches South

Pan American Airways will deliver to Latin America and other foreign lands 20,000 copies of the first air express edition of *Time* magazine on May 5.

Canadian Colonial Airways proposed charter service between Montreal, Canada and Nassau, Bahamas, with overnight stop at Jacksonville, Fla., is being investigated by the CAB at the request of PAA. Pan American has requested the board not to grant further flight authorizations. CCA has installment plan for purchase of travel, and special all-expense ski cruises.

Mayflower Airlines is applying for a certificate between Boston and Nantucket, Mass., with intermediate stops.

Eastern Airlines and TWA are applying for a certificate between St. Louis, Mo., and Washington, D. C.

Braniff Airways declares intention to apply for a line between Dallas and New Orleans, via Shreveport, Alexandria and Baton Rouge.

Northeast Airlines announces 74 percent increase in passengers in northern New England in February over same month of last year. The company operated 103,500 miles in New England and Canada.

Trans-Canada adds six new Lockheed Lodestars with a top speed of 263 mph. A third daily transcontinental trip, Vancouver, B. C., and Montreal, Que., is being planned.

American Air Lines' medical director Dr. Hodges McKnight says the characteristics of air line pilots are: "Good humored, friendly, happy, with poise and self-respect, frank, alert, relaxed; socially well-adjusted, cooperative, adaptable and enthusiastic." Unquote. Hallelujah!

Federal Communications Commission has amended its rules governing aircraft. One permits use of surface ship telephone frequencies for safety purposes by aircraft over the sea. The expiration date of non-scheduled aircraft licenses is advanced from April 1 to August 1.

United Air Lines announces that after 13 years veteran pilot Capt. W. D. "Bill" Williams finally gets credit for the first radio contact flight in the history of scheduled flying. UAL will purchase 15,000,000 gallons of gasoline in 1941. One coast-to-coast flight takes 1,475 gallons.

PCA inaugurates its new run to Birmingham with a big sendoff.

TCA in CANADA carried 53,180 passengers during 1940, an increase of 146 percent over the previous year.

Used for
SAFETY *and* ECONOMY
on all American Military and Transport Airplanes

Every Elastic Stop Nut embodies the resilient non-metallic collar which automatically takes up all thread play and holds the thread faces of nut and bolt in a constant pressure-contact . . . thus creating a vibration-proof grip.

ELASTIC STOP NUTS have been proved safe in every test, and through fourteen years of successful service on airplanes of every size and type, operating under all flying conditions. Their application is approved by all of the military and civil authorities.

From the standpoint of economy, their single-unit construction and automatic self-locking action save valuable time, both in original installation and in maintenance.

Now made in more than 2500 combinations of type, size, thread system, and material...to meet every aircraft requirement ...they are universally recognized as the standard fastening device of the industry.

Catalog contains a graphic explanation of the Elastic Stop principle, presents test and application data, and lists the complete line of nuts.

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Elastic Stop SELF-LOCKING NUTS

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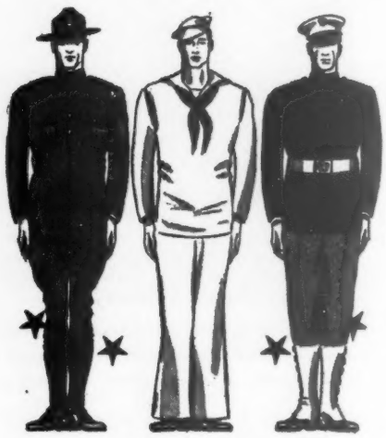
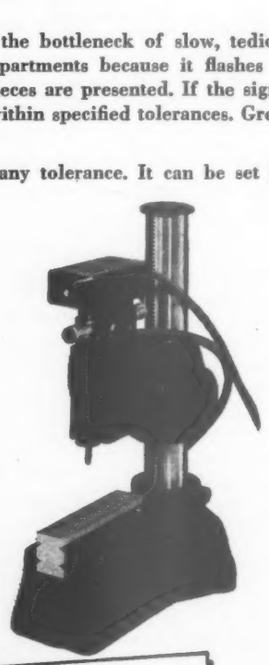


The Sheffield Electrigage has eliminated the bottleneck of slow, tedious dimension checking in many inspection departments because it flashes its answer instantly—just as fast as the work pieces are presented. If the signal light flashes amber the part being gaged is within specified tolerances. Green shows oversize, red undersize.

The accuracy of this gage is .000010" at any tolerance. It can be set for tolerances from .012" to .000050".

The Electrigage is flexible, consisting of a gaging head, light unit and base. The three elements may be used in one assembly for inspection department work or for checking purchased parts on arrival. The gaging head may be mounted on a machine to check parts in the process of manufacture while still on the machine. In such use the light unit may be assembled with the gaging head or with other light units at some location which would permit the control of several machines by one man.



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SHEFFIELD

GAGE CORPORATION • DAYTON, OHIO, U.S.A.

MASTER GAGEMAKERS

Recent Awards

War Department

Douglas Aircraft Co., Santa Monica, Calif., $1,195,864 for airplanes.

King-Seeley Corp., Ann Arbor, Mich., $101,660 for eliminators and valves.

Culver Aircraft Corp., Columbus, Ohio, $245,625 for targets.

Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $120,420 for indicator and controller assemblies.

Bendix Aviation Corp., Bendix, N. J., $492,050 for assemblies.

The Holtzer-Cabot Electric Co., Boston, Mass., $198,000 for inverters.

Curtiss-Wright Corp., Clifton, N. J., $182,655 for propeller assemblies.

Curtiss-Wright Corp., Clifton, N. J., $272,231 for parts for Curtiss propellers.

Bendix Aviation Corp., South Bend, Ind., $159,070 for strut and axle assemblies.

Continental Machines, Inc., Minneapolis, Minn., $207,765 for machines.

Greenfield Tap & Die Corp., Greenfield, Mass., $68,712 for dies and taps.

Manning Maxwell & Moore, Inc., Bridgeport, Conn., $57,000 for assemblies.

Rohm & Haas Co., Philadelphia, Pa., $64,975 for plastic sheets.

Square D Co., Elmhurst, N. Y., $222,000 for indicator assemblies.

Bendix Aviation Corp., Bendix, N. J., $3,186,315 for indicator and tube assemblies.

Kollsman Inst. Div. of Square D Co., Elmhurst, N. Y., $645,005 for indicators & tube assemblies.

Square D Co., Elmhurst, N. Y., $764,318 for tachometer indicators and generators.

Square D Co., Elmhurst, N. Y., $2,745,985 for altimeter assemblies.

General Electric Co., Schenectady, N. Y., $18,040,429 for superchargers.

Bendix Aviation Corp., Bendix, N. J., $1,942,560 for drift meters.

A new name has been given to the former Bredouw Aeromotive Corp. of Kansas City, Mo. Homer L. Bredouw, president, announces that the firm will be known as Missouri Aviation Corp. from now on.

Tri-State Aviation Corp. is now the name of the former Sky Sport Associates, Inc. of Cincinnati Airport, Sharonville, Ohio. John Bogart is president of the firm, and there has been no change in personnel. Tri-State is distributor for Culver Cadet, Akron-Funk and Ercoupe.

AVIATION'S Eighth Annual Directory Issue (February, 1941) is supplemented by the following data:

Bibb Mfg. Co., Macon, Ga., listed under "Fabrics, Upholstery," more specifically manufacture webbing—for parachutes, gunners' belts, and bomb slings.

Doak Aircraft Co., 1559 Sepulveda Blvd., Hermosa Beach, Calif., manufactures aircraft parts and is now in production on an all-wood molded plywood tandem low-wing monoplane primary trainer. Officers are: Edmond R. Doak, president and chief executive officer; Woodson C. Deeds, vice president in charge of production; Keith Rider, vice president in charge of engineering; Reed Parkin, secretary and treasurer.

Godfrey Mfg. Co., New Brunswick, N. J., manufactures motors. Officers are: E. H. Godfrey, president and chief engineer; Lee Beatty, vice president and plant manager; F. B. Clewell, charge of production design; E. K. Goodwin, purchasing agent; Fred Inten, production manager.

Jardur Import Co., 21 W. 19th St., New York, N. Y., manufactures chronographs, stop watches and flight calculators. Officers are: H. H. Clapper, sales manager; C. W. Cromwell, advertising manager; J. J. Waters, purchasing agent.

By Raymond Hoadley

Despite the wartime boom in the aircraft industry, the performance of this group in the stock market has been disappointing to investors. Although earnings are at record levels in most instances and huge backlogs of unfilled orders are carried on the books, aviation stocks recently sold below the May-June lows of 1940. On the favorable side, further gains in earning power, increased dividends and the new amendments to the tax law, which will afford some relief to "growth" companies from the excess profits taxes, might be cited. Unfavorable factors are the risks of deflation that a return to peace might bring and the fact that taxes will absorb a major portion of the profits bulge. The unfavorable factors apparently predominated in the public's mind during the first quarter of 1941. Airline stocks, on the other hand, are selling substantially higher than the manufacturing units of the industry on the basis of earning power, but here the prospective buyer evidently feels that the air transport group is attractive in terms of long-term growth prospects and that its progress will be enhanced by the return of peace.

Domestic air lines flew close to 76,000,000 revenue passenger miles in February, according to the estimates of the Air Transport Assn., reversing the usual seasonal downtrend for the first time since 1937. The gain over January's comparatively poor showing amounted to around 11 percent while an increase of 42 percent was made over the corresponding February of 1940. Eastern Air Lines reported an 18 percent gain last month over January while the gains for some other lines were: United, 5 percent; American, 1.5 percent; Penn-Central 20 percent. The larger February volume is attributable to excellent flying conditions, winter vacations in the South and West and national defense travel. Year-to-year gains in 1941 probably will be somewhat smaller than those in 1940 due to the damper the defense program has placed on expansion of the existing air routes and the procurement of large fleets of additional transports.

Douglas Aircraft was not subject to the excess profits tax last year, with the result that its gain in 1940 earning power far oustripped that of any of the large aircraft companies. Profits of $18 a share on the capital stock compared with $4.81 in 1939. However President Donald Douglas cautioned his satisfied shareholders that profit margins will be smaller this year on the vast amount of United States defense orders than they were in 1940 on sales that went predominately to the British. Well over half the company's present backlog is on a cost-plus-fixed-fee basis.

In addition to the Glenn L. Martin Co.'s current backlog of $350,000,000, this company has order letters and letters of intention which, when finally contracted for, would bring the total backlog to approximately $482,000,000. Martin's sales in January ran up to $6,228,000, a total one-fifth as large as the preceding twelve months combined. Deliveries for the entire first quarter of 1940 were the largest for any three month period in the company's history. When all plant expansions are completed at Baltimore and Omaha, Martin will have an output capacity of over $47,000,000 a month or around $500,000,000 a year—an amount equal to the annual production of the entire industry three years ago.

Recent transactions by aviation officials in the stock of their own company, as reported by the Security and Exchange Commission, include the purchase of 1,250 shares of American Airlines by Orval Mosler and 466 by President C. R. Smith; the sale of 1,000 shares of Bell Aircraft by Lawrence D. Bell and 1,000 by Ray P. Whitman; and the sale of 1,000 United Air Lines by William A. M. Burden.

United Aircraft Products, an aircraft accessory company, may do a total volume of nearly $12,000,000 this year. Previous record was set in 1940 when sales jumped to $3,630,000 from the previous peak of $794,000 in 1939. Unfilled orders approximate $7,000,000 at present.

Bell Aircraft sales this year are expected to total about $40,000,000, or eight times the 1940 output when plants were expanded and tooled up to care for large United States and British orders. Deliveries have started on both orders.

Several aviation companies have announced new financing, the proceeds of which will be used to retire bank debt or purchase new equipment. National Airlines of Jacksonville, Fla., will offer 40,000 shares of common stock for public sale; Rearwin Aircraft & Engines, Inc., plans to sell 220,000 common shares; while United Aircraft Products has registered 75,000 shares of convertible preferred with the SEC. TWA, on the other hand, has drawn $750,000 against a revolving credit of $2,500,000 recently arranged with a group of banks to finance the purchase of new equipment.

Air express shipments passed the 1,000,000 mark in 1940 — the largest one-year total in the thirteen-year history of the service. The tonnage handled amounted to 3,850 tons, a gain of 31 percent over 1940 while the average weight increased almost ½ lb. to 7.1 lb. Domestic air service revenue for the year exceeded $3,000,000.

Industry Backlog

Unfilled orders of the aircraft industry now aggregate $3,875,000,000, a gain of $100,000,000 in the past month and nearly four times as large as a year ago. Meanwhile plans are being developed for further major expansion that will postpone until some more distant date the completion of the current program under which deliveries would begin to taper off towards the end of 1942. Actual orders placed so far amount to around 37,000 aircraft, of which the United States has ordered 21,000 and Great Britain and her allies the remaining 16,000. Preliminary to the placement of large bomber contracts for which appropriations will be forthcoming shortly, the automobile industry has been recruited to tool up plants and, in some cases, construct new facilities for parts and subassembly manufacture under the direction of several prominent aircraft companies. Under this billion-dollar production plan orders totaling as much as $500,000,000 initially will be subcontracted with the motor car makers. The following table gives the latest approximate unfilled orders of 25 primary producers.

Allison	$234,000,000
Aviation Corp.	20,000,000
Beech	24,000,000
Bell	62,500,000
Boeing	200,000,000
Brewster	103,000,000
Buick	91,000,000
Cessna	26,000,000
Consolidated	325,000,000
Continental	40,000,000
Curtiss-Wright	500,000,000
Douglas	350,000,000
Fairchild	20,000,000
Ford	122,300,000
Grumman	60,000,000
Lockheed	270,000,000
Martin	350,000,000
N. American	210,000,000
Northrop	27,000,000
Packard	217,000,000
Republic	60,000,000
Ryan	10,500,000
Studebaker	33,600,000
Un. Aircraft	425,000,000
Vultee	93,000,000
	$3,874,900,000

Current Earnings Report

Company	Period	Net Profits 1940	Net Profits 1939	Profits per share 1940	Profits per share 1939	Sales 1940	Sales 1939
Aero Supply	12 mos. Dec. 31	$554,257	$138,501	$1.29	$0.28	.....	.....
Aviation Corp.	12 mos. Nov. 30	88,350	d2,238,049	0.02	....	$5,235,439	$3,301,779
Cessna	3 mos. Dec. 31	d35,405	.....	....	....	.....	.....
Douglas	12 mos. Nov. 30	10,831,971	2,884,197	18.05	4.81	60,970,774	27,866,658
Ex-Cell-O Corp.	12 mos. Dec. 31	1,982,555	872,302	4.99	2.21	.....	.....
Eaton Mfg. Co.	12 mos. Dec. 31	2,994,657	2,707,040	4.25	3.84	.....	.....
Hayes Mfg. Co.	12 mos. Dec. 31	d39,200	87,153	....	....	.....	.....
Irving Air Chute	12 mos. Dec. 31	411,136	381,829	2.08	1.93	.....	.....
Lockheed	12 mos. Dec 31	3,165,675	3,132,918	3.17	4.09	44,936,595	35,308,149
G. L. Martin Co.	12 mos. Dec. 31	4,306,489	4,110,605	3.92	3.75	30,663,337	.....
Northwest Airlines	7 mos. Jan. 31	133,624	.....	0.57	....	.....	.....
Ryan	12 mos. Dec. 31	358,344	90,728	0.82	0.24	3,864,576	1,085,569
Square D Co.	12 mos. Dec. 31	2,023,203	1,038,491	4.56	3.02	6,324,666	2,849,462
Taylorcraft	12 mos. Dec. 31	57,069	25,488	0.25	0.15	11,572,211	8,308,263
TWA	12 mos. Dec. 31	d232,455	107,133	....	....	.....	.....
United Aircraft Prod.	12 mos. Dec. 31	381,089	104,712	1.91	0.77	.....	.....
Western Air Express	12 mos. Dec. 31	139,585	74,556	0.34	0.18	3,630,937	794,051

d—deficit.

for DEFENSE
against DIRT
KEEP IT CLEAN
with
PUROLATOR
IN THE PLANT
Purolator lube oil filters are now widely used to guard against the dangers of dirty oil in block tests of aviation engines. Purolator meets this problem with the experience gained in producing a great majority of the filter equipment used on gasoline and Diesel engines of all kinds.
IN THE 'PLANE
Another important Purolator development is a thoroughly dependable filter for the hydraulic systems now installed in practically all of the 'planes using retractable landing gear, wing flaps, and other mechanisms used in the armament of Army and Navy fighters. The G-159J Purolator illustrated will handle 12 g.p.m. of 100 SSU oil at 100°F. with a minimum of 12# pressure drop. Operating pressures are up to 1500#. Weight of this unit is one pound four ounces
PUROLATOR
Oil Filters
PUROLATOR PRODUCTS, INC., NEWARK, NEW JERSEY

The hint of dividend payments in the near future is seen by Wall St. observers in the decision of Continental Motors to sell 60,000 shares of preferred stock and which would result in estimated net proceeds to the company of $1,310,000. Some of this new money would be utilized to redeem all outstanding Reconstruction Finance Corp. loans. Officials point out that, through such refinancing, the restrictive agreements in the RFC loan agreements would be removed, which, in turn, would enable the company's directors to declare such dividends out of future earnings as might seem warranted at the time.

TWA stockholders are warned that operations during the early months of 1941 will result in substantial losses. President Jack Frye in his annual report points out that weather conditions last winter resulted in more flight cancellations than in any comparable period in TWA's history. However, if revenues reach present expectations, states the report, the relatively poor showing of the early months should be more than offset in later months. Heavy expenses, including the cost of training a 45 percent increase in personnel, cancelled out a 39 percent gain in gross revenues in 1940. Mr. Frye estimates that his company, on the basis of the CAB's present air mail formula, will receive only $2,900,000 in mail revenue this year "despite the fact that we will be carrying larger mail loads." TWA's mail revenue totaled $3,150,500 in 1940.

In addition to a present backlog of more than $200,000,000, Bendix Aviation officials have counted up another potential $100,000,000 in orders which probably will be received under the present defense program. One year ago the company had unfilled orders of around $50,000,000. According to present schedules, production should reach its peak by next September.

Scheduled production by the American aircraft industry of 37,000 military planes during the next 18 months is nearly one-half the 85,000 planes of all types produced in this country during the 37 years since the Wright Brothers first flew, stated Richard W. Millar, president of Vultee Aircraft, in a foreword accompanying the company's annual report.

Here and There . . . *Northwest Airlines'* common stock has been listed on the N. Y. Stock Exchange while the shares of Cessna Aircraft are expected to appear on the N. Y. Curb soon. . . . Personnel at *Vultee* will reach its peak the latter part of 1941 when 17,000 persons will be employed, as compared with 850 on Dec. 1, 1939 . . . *Glenn L. Martin Co.* will reach capacity output in the spring of 1942 . . . *Lockheed* is producing twin-engined bombers for Great Britain at the rate of four a day . . . *Pan American Airways* will merge seven subsidiary units into the parent organization in the interests of greater efficiency and economy . . . *Eaton Mfg. Co.* is making 75 different items for the aircraft industry . . . *Air Associates* paid a 12½c. dividend to common shareholders on March 25 . . . Merger of *Aviation Corp.* and *Aviation & Transportation Corp.* has been approved by stockholders of both companies . . . *Douglas Aircraft* records a loss of $398,635 on its 1940 sales to the United States Government . . . Backlog of the *Kellett Autogiro Corp.* has risen to $2,208,000, highest total in company's history . . . *Beech Aircraft* expects to finish up its $24,000,000 present backlog by October . . . *Culver Aircraft* of Wichita, Kan., is turning out three to five planes a week for civilian customers . . . *Chrysler Motors* has a new liquid-cooled engine which may be ready for production in 1942 . . . *Hayes Mfg. Co.* will start work soon on a $5,000,000 parts order from Brewster Aeronautical . . . Incoming orders of *Aero Supply* surpassed shipments in 1940 and backlog at the year-end stood at $3,156,000 . . . *Cessna* has received an additional order from the Royal Canadian Air Force for approximately $15,000,000.

Showing more than 300 percent gain over corresponding figures for 1939, the 1940 report of the Ryan Aeronautical Co. and its wholly owned subsidiary, the Ryan School of Aeronautics, shows operating revenues for the year ended Dec. 31, last, as $3,864,575.66 as compared with $1,085,568.74 in 1939. Net profit for 1940 was $218,834.30, against $23,011.85 in 1939. Sales and operating revenue for 1940 was divided as follows: To U. S. Government, $363,735.84; for export, $1,455,465.06; domestic sales, $1,222,187.40; and Ryan School of Aeronautics tuitions and other revenue, $823,187.36. Backlog as of Dec. 31, 1940, was $10,500,000, as compared with approximately $1,500,000 the previous year.

Reynolds Metals Company, manufacturers of aluminum alloy, showed a net profit for 1940 of $4,045,043 before income and tax deductions were made.

NATA Forms Ground School Section

Initial steps to organize the Aviation Ground Schools Service Section of the National Aviation Training Assn. were taken Feb. 21-22 at a meeting in Kansas City. Twenty-two schools were registered. An organization committee of five was elected to convey this convention's recommendations to the NATA Board of Governors.

The committee members are Don Frye, representing several schools under the name of Frye Aircraft Co., and Ralph E. Oliver, Midland Radio & Television Schools, both of Kansas City; J. W. Borton, General Airmotive Corp., Cleveland, Ohio; John Wilson, Lewis School of Aeronautics, Lockport, Ill.; and Frederick H. Roever, Parks Air College, St. Louis, Mo. A board meeting was called for March 17, at the Willard Hotel, Washington, D. C., by William A. Ong, NATA president.

One declared purpose of the Ground Service Schools meeting was to raise the ethics and standards of that division of aeronautical training. Fred M. Lanter, chief of CAA general inspection, speaking at the convention dinner, offered all possible aid to the group in efforts to repress "fly-by-night" or "gyp"aviation training schools.

Resolutions adopted and purposes declared included:

1. Affiliation with the NATA.
2. Declaring tentative statement of code of ethics.
3. Purpose to elevate standards of aviation ground training schools.

New Finance Service for the Southwest

Gene Royer, veteran aircraft finance official of Ft. Worth, Tex., announces the formation of AIRCREDIT, Inc., a new finance company devoted exclusively to serving the southwest aviation industry. Headquarters of the new firm are located in the Terminal Building, Meacham Field, Ft. Worth, Tex.

The Aircredit finance plans provide complete facilities for the time-sales purchase of new and used aircraft, motors, parachutes, instruments and aircraft overhauls. An entirely new innovation has been presented to the southwest distributors and dealers in the new Aircredit Finance Kit and Predetermined Balance Rate Chart, a feature designed to greatly simplify the handling of installment sales.

Officers and directors of the new corporation include: President, Gilbert Harrison, Jr., Brownwood, Tex.; vice president, Sterling Holloway, Ft. Worth, Tex; treasurer, Marshall Cloyd, Dallas, and Gene Royer, executive secretary and general manager. All are well known figures in southwest aviation circles.

Sinclair Flight Trainer

After a successful winter in the south, the Sinclair Flight Trainer is heading north where it will be seen at various airports during the spring and summer. Looking like an abbreviated airplane without wings, the Trainer is rigged 15 ft. above the ground and can duplicate flight maneuvers. An

The Sinclair Trainer

electric motor turns a propeller which blasts a 75 m.p.h. wind back over the pilot. The trainer has been endorsed by NAA and is owned by the Sinclair Oil Co.

Lincoln, Neb. An airfield for every Nebraska county seat with a population of 2,000—this has long been the dream of L. E. Tyson, engineer for the Nebraska State Aeronautics Commission. It begins to look now as if this dream might become a reality.

Since last July, when funds became available from the $20,000 appropriation voted by the last legislature to assist towns to establish fields—the assistance to each town to be not more than $900—fourteen fields are either open for traffic, or soon will be. Those already in use are at Atkinson, Auburn (it is at the Auburn field that students at the Peru Normal School will get their CAA training), Fairbury, Fremont, Chadron, and Holdrege. At Overton, a new CAA intermediate field has recently been completed. Fields for which arrangements have been made are at Clay Center, Chambers, Hebron, Tecumseh, Kearney, Wayne, and Nebraska City.

Thirty-one airports and fields were in existence in Nebraska two years ago. Three of these were at Lincoln. The Union airport at Lincoln some time ago was closed for commercial use, and is now being used by the United States Army as a civilian training center. A field at York was closed and has never been reopened; but Holdrege, which lost its airport for about six months, was enabled by the commission to re-establish it. Less than the $900 allowed by the commission has ben used in many towns, where citizens have been able to contribute work or money, and this fact. Tyson says, will make it possible to establish more fields than were first expected.

Air marking has been completed in 275 Nebraska towns, greatly facilitating air travel over the state. Both Tyson and I. V. Packard, secretary of the aeronautics commission, agree that eventually every town with a large enough building will be air-marked, and that landing facilities will be established every 30 square miles.

Wellsville Aviation Club of Wellsville, N. Y., announce its air meet for July 4 and 5. Crowner Field will be the scene of air races, stunts and air events of many kinds. All pilots attending the show will receive one free meal per day as guests of the club.

The Second Annual Aviation Conference of New England will be held in Boston on Friday and Saturday May 23 and 24.

W. P. Odom, 4631 Madison Ave., Kansas City, has taken over the Culver Cadet agency there with headquarters at the Municipal Air Terminal.

Mid-Continent Airlines, Inc., previously headquartered at the Municipal Air Terminal, Kansas City, moved the first of January into uptown offices in the Fairfax Building, Eleventh St. and Baltimore Ave. A city ticket office has been established at 1111 Baltimore, which location will serve also as quarters for the sales and traffic division.

Approximately two-thirds of the entire fifth floor of the Fairfax Building (2,200 sq.ft. of space) is occupied by the executive, accounting and purchasing departments of MCA. A parking lot adjoining the city ticket office makes this the first airline "drive-in" ticket office in the country.

The operations department will be maintained in the airport building (which is leased by MCA from United Air Lines), and the flight control department will be moved from the terminal building into the main hangar.

The move was the result of airline expansion which saw the personnel of MCA increased 100 percent during the last year. Forty-five persons are employed in the administrative offices. Private offices have been established for Thomas Fortune Ryan, III, president, and J. W. Miller, executive vice president and general manager.

Fly-Ur-Self Waco

A flying mission, headed by H. Terrell Van Ingen, vice president of the Ambulance Corps, is now visiting 130 cities in the South, Southwest, and Middle West in a Waco airplane chartered from Howard Ailor's Fly-Ur-Self System, to organize and coordinate the drive for funds to purchase automobile and airplane ambulances for the British.

History of Harris Hill

To publicize the 12th National Soaring Contest to be held there from June 28, through July 13, a pamphlet chronicling the development of Harris Hill, Elmira, N. Y., as the gliding capital of the United States has been circulated. Starting with a passing observation of the terrain by a nationally famous glider pilot, a successful trial soaring flight was held there in August, 1930. A month later, the first National Soaring Contest was staged by the National Glider Assn. and financed by the Elmira Assn. of Commerce. Today, every accommodation for visitors and visiting planes will be found during the forthcoming national contests.

Culver Cadet Paces "Meteor"

Marvin Jenkins flys his father, "Ab" Jenkins, famous auto racer and mayor of Salt Lake City, to and from Bonneville Salt Flats in a Culver Cadet he recently purchased.

"Ab" burns up the Salt Flats while Marvin sets a pace in the air.

TRAINING

UAL School

As part of its general educational program, available to all company personnel, United Air Lines is experimenting with a work simplification school for supervisory heads of its organization.

Three different groups of United's supervisory personnel have enrolled in the school, being conducted by Allan H. Mogensen, noted authority on work simplification methods, at the company's general headquarters in Chicago. The course extends over a 16-week period, with meetings once every two weeks. Groups attending include executives, department heads, engineering and maintenance officials, station managers, crew chiefs and assistant crew chiefs, numbering about 50 in all and drawn principally from United's supervisory personnel based at Chicago.

The purpose of the school is to acquaint those in supervisory positions with latest methods in the intelligent planning and accomplishment of work programs, with particular emphasis on routine and production matters. If favorable results are obtained from the experimental course, it may be extended to supervisory personnel all along United Air Lines' coast-to-coast and Pacific Coast system.

Perry Institute

Although planned originally for training in essentially peacetime occupations, the J. M. Perry Institute of Trades, Industries and Agriculture of Yakima, Wash., which held first classes on Jan. 2, opens at a particularly opportune time, from the point of view of the national defense effort.

Most directly related to defense needs are the one-year courses in aircraft mechanics, aircraft engine mechanics, and aircraft radio mechanics, and the special three month instruction in aircraft sheet metal work. These, with the three month welding courses have already filled their quotas of students. The Institute also offers courses in the several building trades, machine shop and tool making, and automotive repair. Tuition fees are $48 per quarter or $192 per year.

The hangar shed, located at the end of the shops section, has a mezzanine floor for precision repair work. It will operate also as a certified aircraft repair shop, according to Frederick G. Leasure, director of the school. Instructors in the aircraft divisions are Roy E. Hoyt, previously with the Boeing Co. in Seattle, Vern St. John, former owner of Commercial Aircraft Co. of Portland, Ore., Edwin H. Timme, aircraft instrument instructor from Boeing's, and George E. Fisher, in charge of aircraft radio mechanics. Total cost of buildings and equipment for the school, endowed as a memorial to her husband by Mrs. J. M. Perry of Yakima, was $516,462.

Spartan Adds 17 New Training Planes

Spartan School of Aeronautics, Tulsa, Okla., in the last few months, has added 17 new training airplanes, making a total of 22 now in operation. Spartan is regarded as having one of the largest and the most modern civilian school training fleets of any aviation school in the United States. Ships now in use on the line are: Four new Fairchild M-62 trainers, four Piper Cubs, three Spartan 450 H.P. Executives, two Spartan Biplanes, three Meyers trainers, two Waco cabin planes, two Taylorcrafts, one Fairchild 24, and the latest type Series E Link Trainer. This department of Spartan School is now putting out instruction at the rate of 1,500 hr. a month.

A new aircraft school, specializing in sheet metal fabrication and layout, riveting, aircraft welding, aircraft construction, etc., will open in Vancouver, B.C., shortly, according to official announcement.

The school, to be known as Mechanical Industries Technical Institute, will occupy a four-story brick building and will be fully equipped with the latest type of pneumatic and mechanically operated aircraft production equipment. It will accommodate 150 to 200 students.

Mechanical Industries Technical Institute will operate under license of Aero Industries Technical Institute, internationally-known aircraft school in Los Angeles. The training offered by MITI will be based on the Aero ITI training which originated in the aircraft industry.

Harvey G. Chapman, Jr., head of the armament division of Aero Industries Technical Institute, Los Angeles, is working closely with the U. S. Army Air Corps to make available for national defense purposes a number of aerial armament developments carried out under his direction by engineering students of Aero ITI. Chapman recently conferred at length with officials of the armament division of the Materiel Division of the Air Corps at Wright Field, Dayton, Ohio.

Developed to present news of school and student activities at the Aero Industries Technical Institute, Los Angeles, *The Plane Builder*, is now being published as a regular newspaper by the students of Aero ITI. A new student store has also been added to the facilities provided on the Aero ITI campus. Aero ITI student activities in recent months have included extensive glider and sailplane design, construction and flying work, the flying work, the flying being conducted as an extra-curricular activity. Students of the school have also constructed a new type training plane of geodetic structural design using spruce strip members throughout wing, fuselage, and empennage. Activity of the engineering students has included complete detailed design, including working drawings, of a small sport and training plane.

AC Hires Thousands

Air Corps officers estimate that they will employ some 175,000 civilians within the next two or three years. This is based on the assumption that three civilians are needed, in addition to enlisted personnel, for the maintenance of each plane. The supposition is that the US will have 50,000 air-planes in service. Branch employment centers are being established at the headquarters of the nine corps areas throughout the country.

Trainers look pretty much alike in all parts of the world. These are made by the Commonwealth Aircraft Corp. for use by Australian youth in military flying.

St. Louis School

The newest addition to the growing list of aviation training schools in the St. Louis area is the Atlas Aircraft Trades School, Tenth and North Market Sts., a subsidiary of the Atlas Aluminum Welding School, which has been training welders since 1914.

W. A. McCullom, for eleven years an instructor in welding at David Ranken School of Mechanical Trades, is president of the new school, Walter F. Wilsdorf, formerly in the employment department at the Curtiss-Wright plant, is general manager. Al Abrahams and Anthony Flowers, two members of the staff of instructors, are qualified pilots and have taught in other aircraft trades schools.

A six weeks' day course and 20 weeks' night course are offered in riveting, sheet-metal layout, template making, blueprint reading, welding, designing and drafting. Classes are held in a new building and each student is furnished a kit of tools and instruments like those used in factory production.

Fraternity at Lincoln School

A fraternity limited to men in the aviation industry has been formed at the Lincoln Airplane and Flying School, Lincoln, Neb. Known as Alpha Epsilon Rho, the membership now is composed of Lincoln students, but all other men in the industry have been invited to join. Doubtless other chapters will be formed.

Chicago School of Aircraft Instruments, Municipal Airport, Chicago, has recently issued a handsome catalog describing its courses and equipment. Ray Snyder of Snyder Aircraft owns the school and Dan Tilden is superintendent.

Republic Aviation Corp. of Farmingdale, N. Y., has been working closely with NYA in the nearby town of Bay Shore, where aviation classes have been set up. Riveting guns, sheetmetal and other equipment has been loaned by the factory, and teachers are also being furnished. Republic also expects to get a number of graduates of the NYA course at Oyster Bay. The Corporation is also paying the tuition of many students at the Faust Sheetmetal School.

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LYON STEEL BENCH LEGS: (No. 2993-11). Durable, for wood and steel bench tops, wood tables, machine mountings and bulk storage platforms. Top and bottom cross members are punched on 3 inch centers for attachment of top and shelf. Upright members punched for attaching stringers or cross bracing. Exclusive features: (1) riveted and welded; (2) reversible front to rear. 28" deep, 32-1/4"high. Finished in green baked enamel. Shipped completely assembled. Ship. wt. 27 lbs. **Price $2.95.**

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Patent No. 2-202-427

LYON "ADJUSTABLE BACK" STEEL STOOL: (No. 1226). Welded, non-breakable. Unusually large, comfortable seat area — 187 square inches. Long life pressed wood seat applied over steel for strength. Forged steel dome shaped foot, 1-1/8" in diameter, assures easy sliding without damage to floors. Green baked enamel finish. Height — 26". Shipped assembled and bundled — not packed or crated. Ship. wt. 14.1 lbs. **Price $2.85.**

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ASSEMBLER'S BENCH BIN: (No. 2963). Accessible storage of 12 different parts in only one square foot of bench area. Individual hoppers (filled from top) are self-feeding. Built of steel and finished in green baked enamel. 16-1/4" wide, 9-1/4" deep, 15" high—overall. Hopper front openings are each 4" wide and 3" high. Loading compartments at top are 4" wide and 3" deep. Ship. wt. 19 lbs. **Price $5.70.**

LYON TOOL STAND: (No. 2970-17). Portable. Flanged top and trays prevent tools and parts from falling off. Includes drawer and padlock attachment — no padlock. Sturdily built — will remain rigid after hard use. Width 24", depth 24", height, with swivel-type steel casters, 37-1/8". Green baked enamel finish. Shipped set up. Ship. wt. 80 lbs. **Price $11.35.**

LYON SHOPROBE: (No. 2065-12). Portable. Double face —20 person capacity. Equipped with 20 non-removable coat hangers. Accessory equipment — chain to run through sleeve of coat and lock with a padlock (not furnished) to the compartment door. Diamond perforated doors. Overall size—50" wide, 36" deep, 75-7/8" high. Finished in green baked enamel. Shipped set up with standards and base detached. Ship. wt. 415 lbs. **Price $52.10** — without chains. (Price of chains 60c each. Ship. wt. of chains 2 lbs. ea.)

ADJUSTABLE SORTING RACK: (No. 2285-1). Has 9 shelves, adjustable every 1/2", forming 12 compartments. Shelves are equipped with label holders. Bottom flanged for stacking. Two racks are illustrated. Sorts mail, shipping papers, job tickets, and stores small tools and sandpaper. 34-1/4" wide, 11-1/2" deep, 10-5/8" high. Shelf width, 10-13/16". Finished in green baked enamel. Ship. wt. 34 lbs. **Price $11.90 each.**

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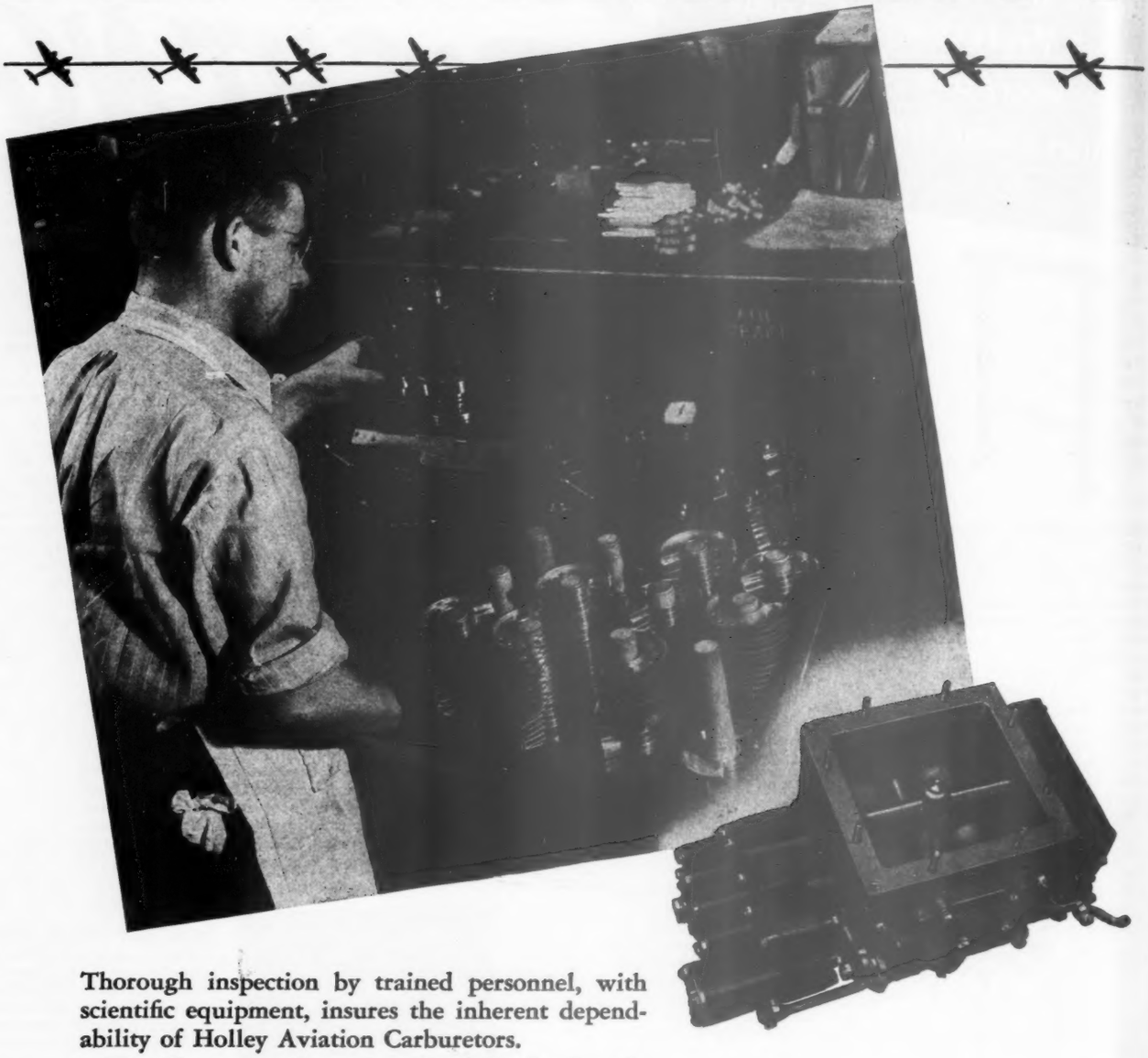
DEPENDABILITY



Thorough inspection by trained personnel, with scientific equipment, insures the inherent dependability of Holley Aviation Carburetors.

The illustration shows how carefully the throttle gears are checked before assembly. This same careful accuracy is maintained throughout the manufacture of Holley Aviation Carburetors.

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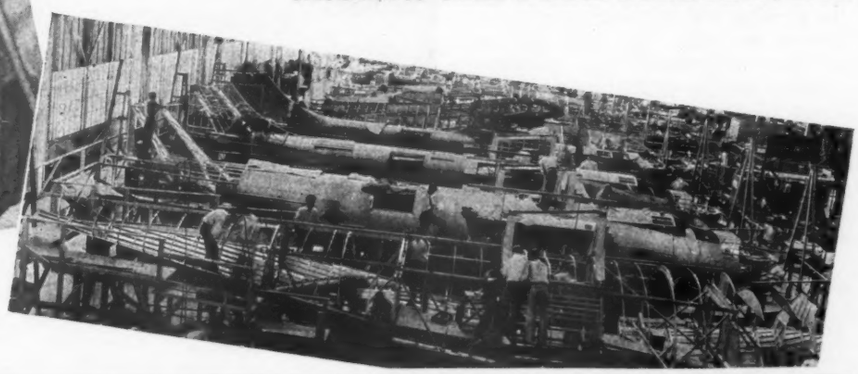

Illustrations from Norcross and Quinn's "The Aviation Mechanic"

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Conveyor Belt System

(*Continued from page* 45)

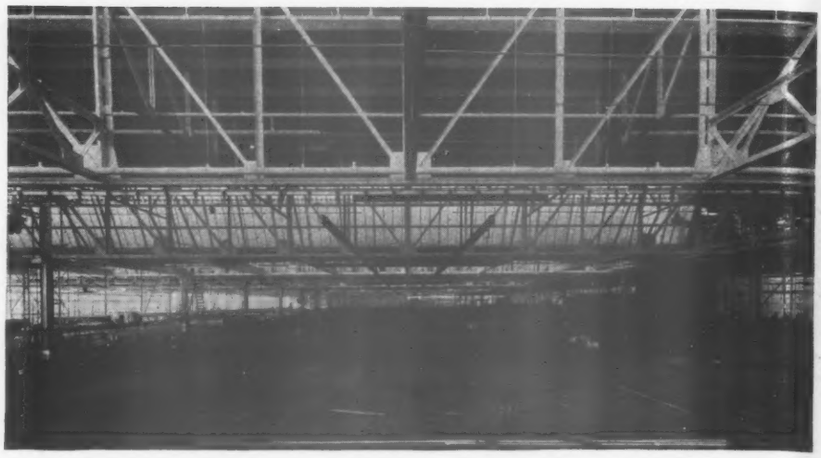
center aisle next to a corresponding series of herringbone subassembly lines for the single-row engines. Thus in little over half the plant (see photograph) the two green lines run down the center portion side by side with their subassembly feeding lines located on the outside edges. The engines are assembled on four-wheel stands (see photograph) in the usual manner, ending up after green assembly at the electrically controlled overhead monorail which carries them into the test house, where the engines undergo "green" tests. The stands on which the engines are assembled on the green and final lines roll in steel channels, sunk into the floor, which is another feature designed to promote the speed of line production.

Near the final assembly lines are specially lighted inspection benches, where parts of engines which have gone through preliminary testing are examined. Suspended over each bench is a row of fluorescent light units which give out diffused daylight in such fashion as to totally eliminate shadow—a feature increasing the efficiency of inspection.

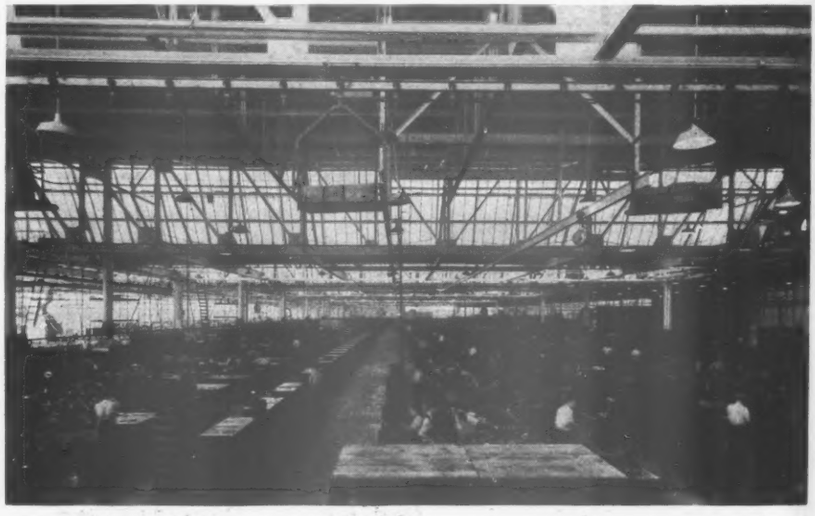
At one end of the final assembly line is the packing and shipping department. Overhead on rails, big 5-ton electric cranes have been installed for transporting boxed engines to the large enclosed railroad loading platform nearby.

Construction work on this building started on Sept. 5, 1940, and by Oct. 16 the steel framework was going up. Actual construction of the building was finished on Jan. 11, 1941. Installation of necessary equipment, including the conveyor system, was completed within the following three weeks.

The building has 371 inspection and assembly benches, representing a total area of 24,800 sq.ft.; 780 bays of steel shelving, representing 23,900 sq.ft. of storage space; approximately 340 large disassembly racks, and 44 hoists, representing an aggregate lifting capacity of 75 tons of aircraft engines. One of the interesting facts was that the schedule of production required that the occupation of the new plant occur without any loss of production, and this was accomplished.



Before (above) and after (below). Above is a view looking down the green assembly lines before the equipment was moved into the plant. At the right is the storage bay with the double conveyor line described in the text. Just above the center of the picture is the conveyor belt where it travels from the twin-row subassembly line over to the single-row subassembly line where it travels down along the plant in the track shown.



Same scene a few weeks later. Here can be seen the pans traveling along the conveyor belt at the top of the picture with assembly work being done on the twin-row engines at the right center. The single-row engine line, although empty, was in the process of being set up.

Right: Over each inspection bench is a battery of special fluorescent lights giving shadowless illumination. After initial testing each engine is disassembled and all parts are laid out on one of these benches for inspection.

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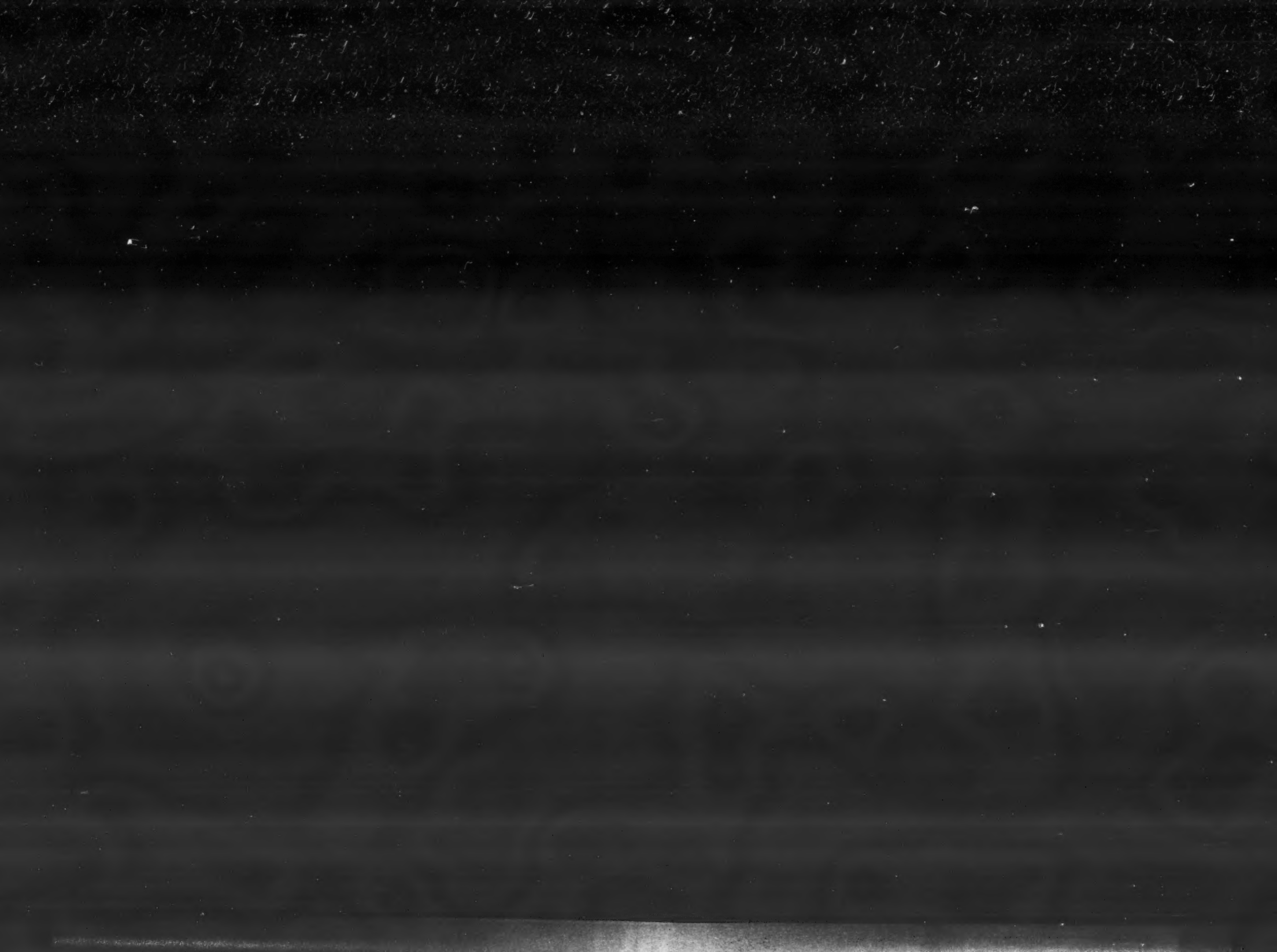

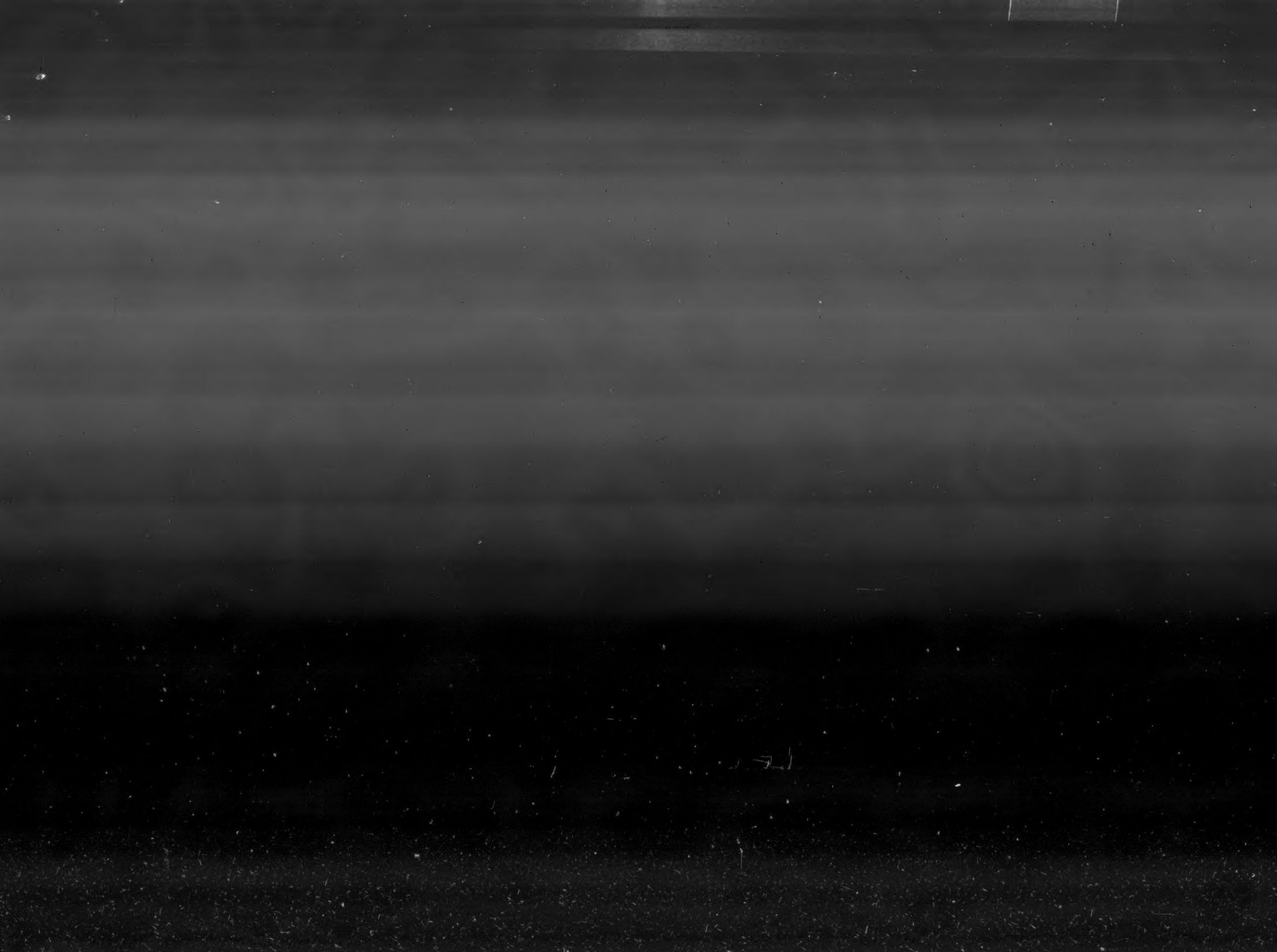

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to FASTER
ASSEMBLING
with
HOLLOW SCREWS

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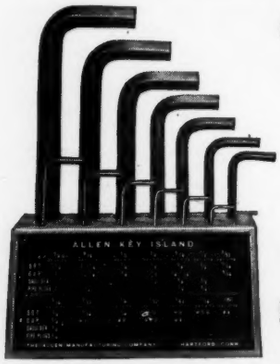

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Ask for Folder X-19

THE ALLEN MFG. COMPANY
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Aviation's Position

(*Continued from page* 80)

$376,890 from this airport asset and reflected such loss in the accounts for previous periods.

As the 1940 annual reports are rapidly becoming history, statements for the early months of 1941 are being released. While the individual companies thus reporting all show important gains in gross revenues, they also invariably show decreased net profits or increased deficits as compared to the same periods a year ago. Increased operating costs of a multiple nature have taken their toll of revenue gains realized. Adverse flying conditions together with a series of crashes have also had the effect of restricting traffic gains that would have been expected as a normal tendency. While some fear has been entertained as to the adequacy of future new plane deliveries, current traffic trends do not appear to crowd the industry's present capacity.

It is these ominous forebodings concerning the curtailment of operations due to lack of equipment and personnel together with the recent crashes and bad flying conditions, that have caused serious slumps in leading air transport stocks. Every major air line security has penetrated important "resistance" points on the downside. From a technical market standpoint, this would ordinarily indicate that such stocks may yet sell lower. In any event, a considerable "trading area" would have to be established before material higher prices in this group could be anticipated.

At the present time there are increasing indications that should operating deficits be long sustained by the air carriers, relief may be sought from the CAB through the "national defense" clause as a basis for fixing mail compensation. Throughout its decisions and in its annual report the CAB has constantly reiterated its belief ". . . to fix airmail rates which will enable the air carriers, under honest, economical, and efficient management, to maintain and continue the development of an air transportation system of the character and quality required for the commerce of the United States, the Postal Service, and the national defense."

Currently, the normal operations of the air lines are being affected by the national defense program in no uncertain manner. It is possible that as a direct result, certain air carriers may experience sustained operating losses. Is it not reasonable to assume that in subsequent decisions the CAB may take this additional factor in consideration when making new rate determinations?

Amendments to the excess profits tax law, as recently approved, should be of direct benefit to the "growth" companies of which the aircraft builders are an outstanding group.

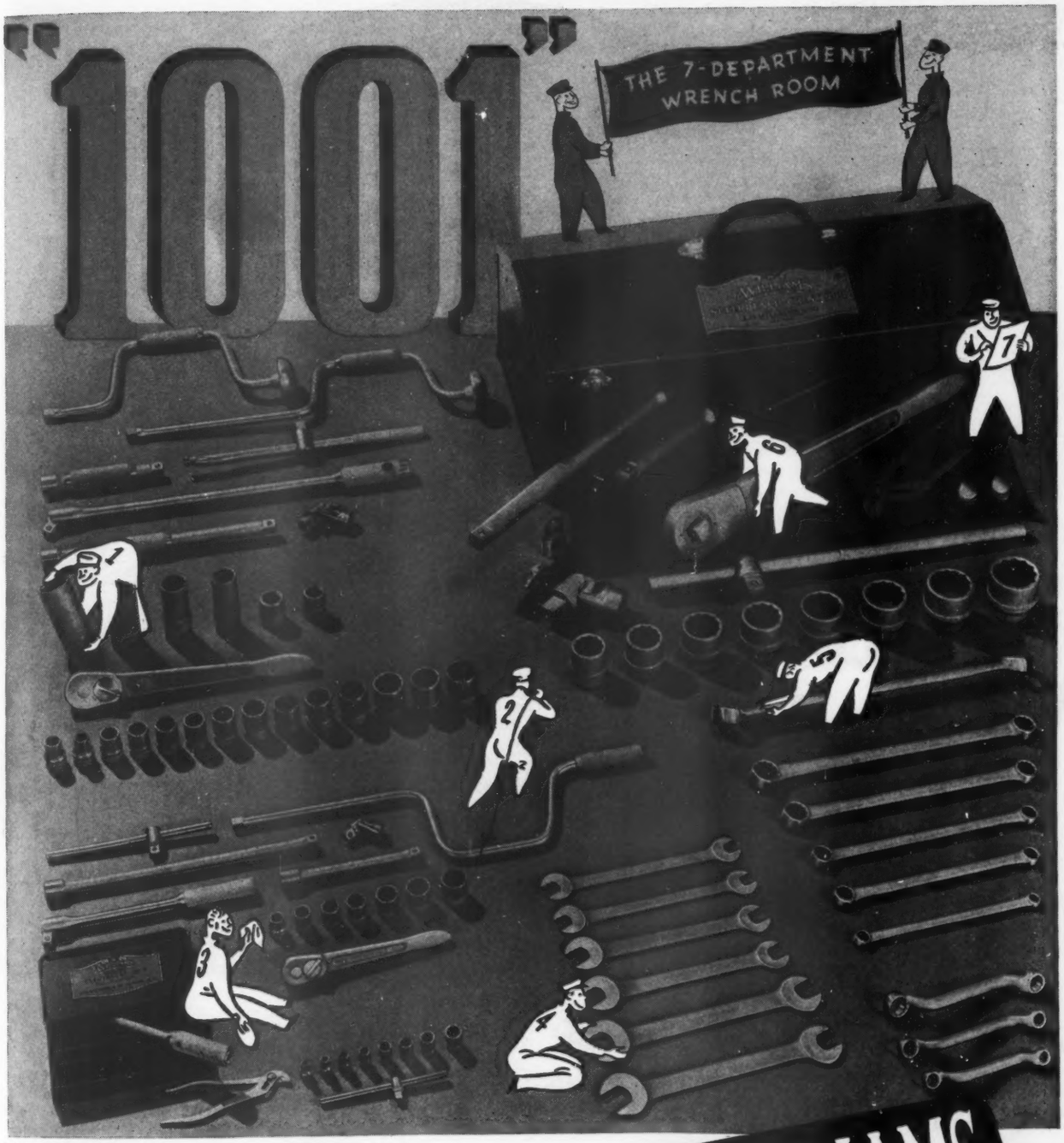
As originally enacted, the excess profits tax applied against all net profits in excess of (1) 8 percent of invested capital, or (2) 95 percent of average earnings for the four years, 1936–39. While the individual corporations had the option of choosing the method which gave them the higher credit base, the law nevertheless penalized the theoretical growth company. To ameliorate this condition the recently enacted amendment permits the credit base to be computed as follows: The average of the first two years' earnings of the base period are subtracted from the average of the second two years. The result is divided by two and this is then added to the average of the second two years. The formula may be used by any corporation when its income in the second half of the base period is greater than in the first half, but the total amount of the credit may not exceed the best year of the base period.

This formula permits the aircraft manufacturers to benefit from the earning power developed in recent years. Table I shows the improvement in earnings credits per share for leading aircraft builders under the new and old formulas.

It is important to note that while these adjustments improve the tax status of the aircraft builders, such changes merely represent amendments to the old law. Yet to come is a new tax bill. With mounting defense expenditures, it is likely that the Administration will seek to pay for this program from current incomes as much as possible.

With increasing discussion of labor difficulties in many defense industries, it is pertinent to note the record as it pertains to the aircraft industry. According to the Bureau of Labor Statistics, the aircraft industry for 1940 showed a total of 21,624,000 man-days worked with only 0.17 percent of man-days idle and a total of 594 man-days worked per man-day idle. This is a highly commendable showing and compares very favorably with other defense industries.

With the enactment of the "lease-lend" bill, the flow of aircraft and other implements of war should be accelerated at an increasing rate to Britain. This development is just one more assurance of a high rate of activity for the aircraft builders. As previously intimated, however, profit margins on all new business should be considerably lower than previously obtained on foreign orders. Nevertheless, once volume production is attained—and it is being attained—profits may be expected to come through.



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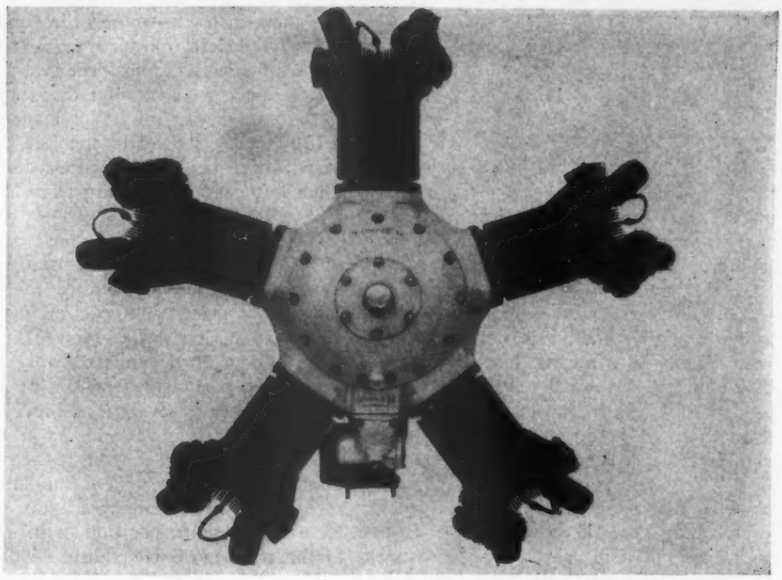

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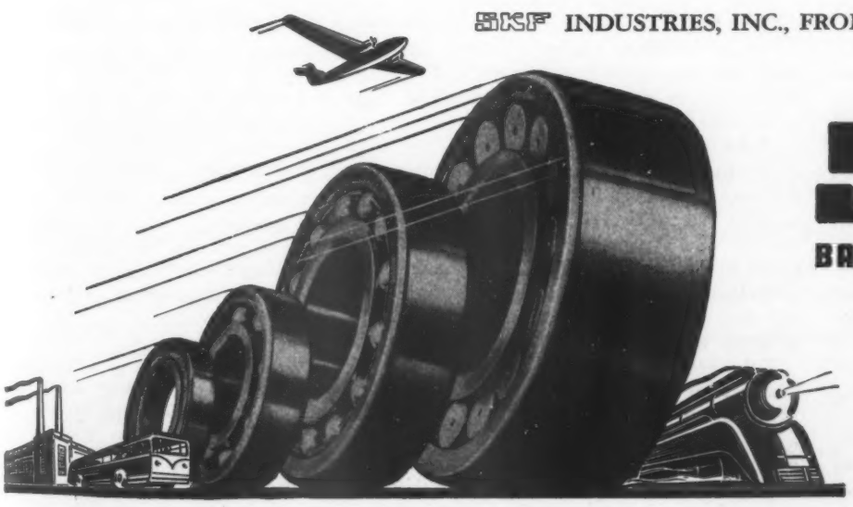

SKF
BALL & ROLLER BEARINGS

Acrobatics Are Easy

(*Continued from page* 33)

throttle back so as to keep the r.p.m. under 1,900 (in Continental and similar engines around 200 hp.). In the Waco trainer, 110 m.p.h. is fast enough for a good chandelle.

To simplify the explanation let's assume that the wind is coming from your right. This means that your chandelle will be made to the right. Having attained the desired speed, put pressure toward the right on the stick, until the right wing has been depressed about 25 deg. At the same time apply *very slight* pressure on the *left* rudder pedal, just enough to keep the nose from swinging to the right. Too much pressure will pull the nose to the left, producing a noticeable side-slip and causing a sloppy maneuver. Having established the bank, relax the side pressure on the stick and apply a smooth, straight, back pressure, at the same time easing off all pressure on the left rudder pedal. As the nose passes the horizon on the way up, gently ease the throttle ahead so that it will be wide open when the ship has made about 90 deg. of the turn.

At this point, which should be checked by glancing at your road, the bank should be nearly vertical and the nose well up. Note that only one control—the elevator—is used for this first half, once the bank has been established.

You should now start your recovery, by applying very light pressure to the left on the stick, accompanied by light pressure on the left rudder pedal. The back pressure on the stick is maintained. You should endeavor to use just enough pressure toward the left to bring the wings level just as 180 deg. of the turn (checked by reference to the road) have been completed. If the wings are level at this point but the ship shows a tendency to continue turning, a slight increase in pressure on the left rudder pedal will check it. Your air speed should be about 45 m.p.h. and your altitude several hundred feet more than when you started. (This latter, incidentally) is the reason you were allowed to start the maneuver at 2,500 ft.; you can gain altitude for the other maneuvers and do practising on the way up). Now gently ease the stick to neutral—not too quickly or you'll settle, yet waste no time, or you'll stall. Leave the engine fully on until cruising speed is attained, then throttle to cruising r.p.m. and perform the maneuver again, this time to the left.

Never neglect this last instruction. In all maneuvers which may be done to the right or to the left, *always* execute them in pairs—one to the right and one to the left, or vice versa. Then you won't become onesided.

Now let's go back and discuss some of the errors you might have made.

If the nose swung to the left during your initial bank, you were using too much left rudder in trying to hold your course.

If you failed to gain much altitude and if your speed was high after recovery, you probably banked too much and simply made a steep climbing turn.

If you stalled before you completed the 180-deg. turn, you probably didn't bank steeply enough.

If you were in straight and level flight before completing 180 deg. you recovered too quickly; if you turned more than 180 deg. you waited too long for recovery. In either case, you should have noted your position with respect to the road more frequently.

If you completed the maneuver satisfactorily but stalled after the wings were level, you were too slow in easing the stick ahead; if you settled after leveling out, you probably pushed the stick ahead too abruptly, thus decreasing the angle of attack below that required of relatively low air speed.

And last, but by no means, least, if the maneuver was just generally sloppy, you were guilty of the serious fault of roughness on the controls. *Handle them gently* in *every* maneuver except the snap roll, and even in that the movements should be smooth.

The Lazy Eight

There is a great deal of misunderstanding in regard to the lazy eight, illustrated in Fig. 2 and so-called because the flight path of the ship, viewed from the side and at same altitude, resembles a figure 8 lying on its side. Viewed from above, the path is a series of S-turns. It is an excellent practice maneuver, and very beautiful when properly performed.

Select a prominent land-mark on or near the horizon, and directly up wind. A large building, clump of trees or small body of water is satisfactory. Fly 90 deg. to an imaginary line extending to the object selected. Leave the throttle set for cruising speed and dive the ship until the speed is slightly above the maximum in level flight. Then begin a fairly steep climbing turn into the wind. (Let's assume the first turn is made to the right.) The turn should be so executed that as a little more than 180 deg. are completed the nose of the airplane will pass through the point.

This accomplishment may be helped along with a slight increase in back pressure on the stick and, if necessary, a little bottom or right rudder. However, if the planning has been accurate, neither will be needed. In fact, the object of the maneuver is to cause the nose to cut the point without last-minute assistance.

As soon as the point is passed, apply light pressure to the left on the stick and rudder and ease off back pressure. If the controls are properly used, the wings will be level just as the ship passes the intersection, as indicated in the figure. The pressure on the left aileron and rudder is maintained without change, back pressure resumed as the bottom of the loop is reached, and a left turn begun by this maintaining of the rudder and aileron pressure. After a little practice the movement of aileron and rudder should be so slight as to be hardly noticeable.

While the illustration shows only one "eight", as many as desired may be made. However, it is only fair to warn you that if you do very many, at any rate until you are used to them, you are very likely to shoot your cookies, put your lunch, or whatever euphemism you wish to use. The lazy eight has turned more stomachs inside out than all the other acrobatic maneuvers combined.

Now for possible faults. Probably the most likely is allowing the ship to dive too steeply on recovery. If you are not careful, you will find yourself diving more and more, picking up so much speed that you will have to use considerable force to pull out. This in turn puts heavier loads on the structure, and on your tummy as well. Don't try to hurry through the maneuver. Make long slow loops—so that you do a "lazy" eight in more ways than one—with the least possible manipulation of the controls.

Your next most likely fault is trying to climb too steeply. This means you'll stall and fall out of the peak of the loop instead of flying out. The remedy for this is obvious.

When you become expert in using a mark on the horizon, you might try taking one a little nearer and working toward it. You will find that as you get closer you will have to bank more steeply, until, when you are just over the mark (if your instructor lets you get that near) you will be doing half-rolls in order to get the nose through the point. This is a little too much for the beginner, but it shows the possibilities of the maneuver from the standpoint of practice.

We next proceed to a very similar maneuver, and one which is often confused with the lazy eight.

The Wingover

The wingover is simply a climbing turn followed immediately by a diving turn. It is illustrated in Fig. 3. By comparing the flight path as viewed from the side with that traced in the

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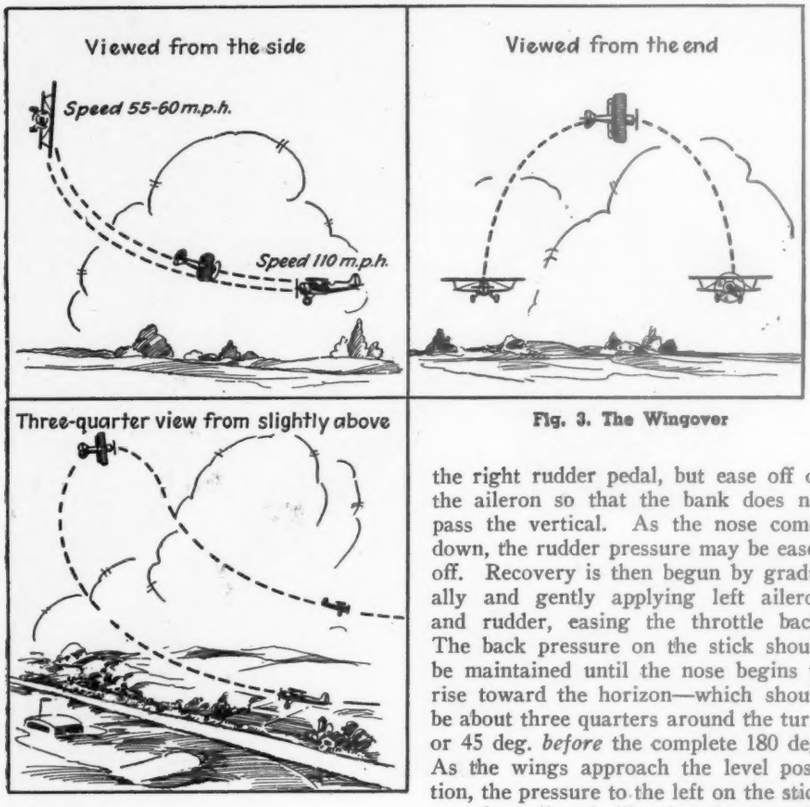

Fig. 3. The Wingover

lazy eight, the difference between the two is immediately obvious.

One nice feature of the wingover is that it may be made as mild as desired for the beginner. Practice may be started with a very gentle climbing turn, with the maximum bank about 45 deg. In the advanced type, the limit of performance is used, as in the chandelle.

Before starting the maneuver, select a road which runs at 90 deg. to wind. The turns should be made into the wind and the road used to check the amount of turn, which should be 180 deg. Let's assume, as in the other maneuvers discussed previously, that the first turn is made to the right.

Fly parallel to the road, and dive slightly, easing the throttle back to keep the r.p.m. at the cruising figure, just as when starting the chandelle. Apply back pressure to the stick, at the same time applying right aileron and rudder, exactly as in making any climbing turn. As the nose comes up and the r.p.m. begin to drop, ease the throttle ahead so that it will be wide open when 45 deg. of the turn have been completed.

Increase the bank and the climb by maintaining pressure on the stick to the right and backward, so that when 90 deg. of the turn have been completed the ship will be in a vertical bank with an air speed slightly above stalling—55 to 60 m.p.h. in the type we are using. At this point, increase the pressure on the right rudder pedal, but ease off on the aileron so that the bank does not pass the vertical. As the nose comes down, the rudder pressure may be eased off. Recovery is then begun by gradually and gently applying left aileron and rudder, easing the throttle back. The back pressure on the stick should be maintained until the nose begins to rise toward the horizon—which should be about three quarters around the turn, or 45 deg. *before* the complete 180 deg. As the wings approach the level position, the pressure to the left on the stick may be relieved, likewise that on the left rudder pedal if straight and level flight is to be resumed. If a wingover to the left is to be executed, left stick and rudder should be maintained and back pressure reapplied as in the repetition of the lazy eight.

The wingover is an exceedingly graceful maneuver. When you have become capable of doing a good one with the use of the engine, you will find that your smoothness and coordination will be improved by practicing them with the power off. In this case particular care should be taken not to stall at the top, since with one wing down, stick back and rudder on the side of the low wing, conditions are ripe for a spin. Hence power-off practice should be conducted at first above 3,000 ft. And speaking of stalls, perhaps we can offer some helpful suggestions on our emphasis on *gentle* use of the controls. It is particularly important here.

The Power Stall

The trainer we are using will rear back with the power on until the nose is almost unbelievably high, and in such a position, responds quickly to the rudder. There is one caution which should be emphasized. *Don't pull the stick back too fast.* If you do, a whip stall will occur, and a whip stall is good for neither man nor airplane. Execute your power stall as described below, and you'll do a better job and also eliminate the possibility of having to use that parachute which we hope you fitted carefully. And remember

With the ship at cruising speed and r.p.m., *wings level,* (be particularly careful about this), gently ease the stick straight back. Continue this backward movement *very slowly* until the nose stops rising. Continue the slow backward movement of the stick until the ship begins to shake or the nose shows a tendency to sink. Then move the stick smoothly, and fairly rapidly, as far back as it will go.

One wing or the other will start to drop. Apply very light pressure to the opposite rudder pedal, relieving the pressure as soon as the wing stops going down. If you hold the rudder on too long, or if you use too much, the other wing will drop and first thing you know, you'll be flopping from one side to the other in a poor imitation of a falling leaf. Then you're licked and might as well let the stick go back to neutral and try again.

If you use proper delicacy, the wing will stop at the level position. Keep the stick hard back until the nose drops and come up again; then repeat the whole process. If you can keep the wings absolutely level through two complete oscillations, or until the nose has dropped and come back up twice, you're good m'lad, you're good.

Don't spoil it by a sloppy recovery. As the nose begins to rise after dropping, gently ease the stick forward to neutral. If you move it ahead while the nose is down, you'll dive and pick up too much speed. However, if you *do dive,* don't forget to close the throttle immediately, until a normal glide is attained.

Remember—ailerons are *not* to be used at any time in this power stall maneuver.

The Falling Leaf

This maneuver follows logically after stall practice. The object is to make the airplane do just what you were trying to keep it from doing in the power stall—namely to drop first one wing and then the other, but continuing to point the nose in the original direction. This last is the real trick. You will experience little or no trouble in making the wings drop alternately, but holding your direction is another story. Once the nose starts to swing to either side you're all through so far as that particular effort is concerned and you might just as well come out of it and begin all over again.

There are one or two little tricks in performing the maneuver correctly. One is to have the center of gravity of the airplane as far forward as possible. If the gas tanks are in the top

(*Turn to page* 140)

Official Photograph U. S. Army Air Corps

DELIVERIES of twin-engine BEECHCRAFTS are now being made at an ever-rising rate for use in connection with the National Defense Program. The U. S. Army Air Corps has released the photograph and data concerning its AT-7 Navigation Trainer shown above:

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BEECHCRAFT

Aircraft Cannon

(*Continued from page 37*)

to indicate to the gunner his line of fire with which to correct his timing, we have the number of rounds available per second at 16. This means that a plane flying 500 ft. will have 16 bullets to contend with, from each gun, providing aiming and lead is correct! Under the conditions where the target is flying directly along the line of fire, i.e., coming directly at, or flying directly away from, a steadily aimed stream of fire, the chances are greater for retaining the target within this line of fire for longer periods. This situation is more prevalent with pilot fixed gunnery. But, reciprocally, the enemy guns also constitute a menace in this position. Even when pursuing enemy fighters it is possible to receive a surprise hail of bullets from a remote controlled gun mounted in the tail which automatically covers the "blind cone" around the tail structure. It is quite apparent that every hit that is made must be effective if it is to accomplish its purpose and for this reason war pilots favor small caliber cannon.

Besides being able to hold an elusive enemy target within the line of fire for longer periods, pilot gunnery is made more effective through the added fire power given by the eight to twelve guns mounted in wings and fuselage, arranged to converge at a point anywhere from 150 to 250 yds., the most common combat ranges. Actually, the guns, mounted in this way, have a practical range of 300 to 500 yds.; beyond these distances the lines of fire of the individual guns would diverge too much for effective scoring. In some foreign installations in the past, particularly in Poland, and in the case of a Dutch fighter by Fokker, provision was made for mechanical variance of the convergence point. While there is reason to believe that such convergence control is advantageous, the extra thought and motion that must be given to the fire control by the pilot, and the installation difficulties of a variance gear, probably offset the advantage.

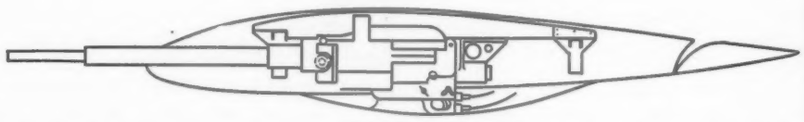
As a result of increased aircraft speeds, fighter and pursuit planes are now designed and equipped to fight with a heavy load of armament, sometimes up to ten or more machine guns and automatic cannon in combination, with which they attempt to dive down on enemy craft to get in but a few short bursts of fire. If they fail to register a hit the first time, they may not get another chance, either because of rapidly decreasing ammunition supplies, or for fear of flying too far afield, considering the speed with which opposing planes can get away, and also considering opposing gunfire. Airplanes can carry but a limited amount of ammunition, too, as the cartridges and cartridge belt boxes or ammunition drums occupy needed space, and, in the case of cannon, a supply for half a minute's firing of each cannon is all that can be carried due to both weight and space required. However, when 200 rounds of explosive shells can be carried, this supply is sufficient for a number of bursts of fire, and every hit that is made will be positively effective.

Even during first World War days, it was recognized that something better than a machine gun was desirable on aircraft. At that time nothing was available except old-type slow-firing, cumbersome 37 mm. cannon, which were experimentally mounted to fire through the propellor hub of the watercooled engines, but were found impractical for many reasons, among them excessive weight and low fire power.

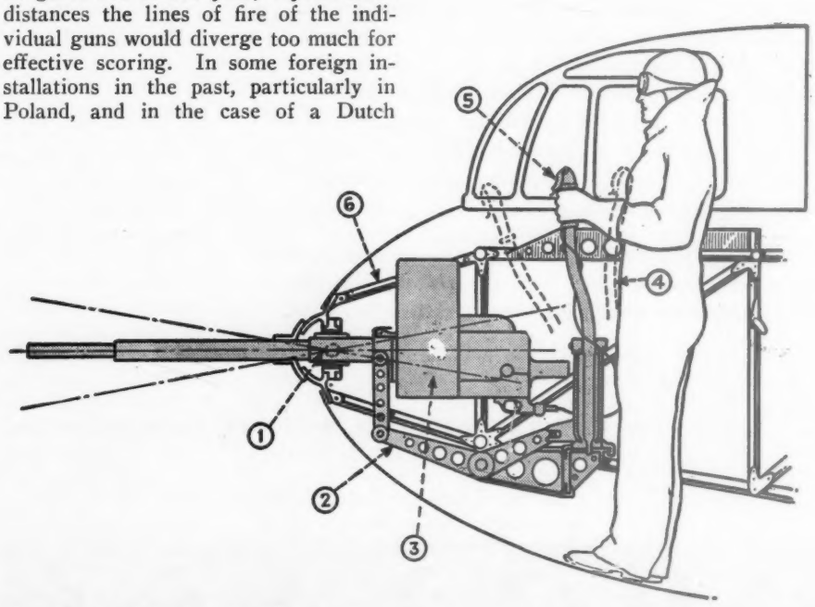
At this writing the picture has changed considerably. Practically all types of planes now require intermediate caliber automatic cannon of the 20 and 23 mm. type, as a vital necessity. Machine guns, both .30 and .50 caliber, still have their field of usefulness and will undoubtedly continue to make up part of military plane equipment. At the other end of the aircraft armament range we have the 37 mm. cannon, of which one type in particular is made by American Armament Corp. These 37 mm. cannon have a comparatively slow firing rate, while the ammunition is fed into them in clips of five shells each, manually by the gunner.

From the table showing the comparative characteristics of the three classes of aircraft weapons, the light and heavy machine guns in the first, the 20 and 23 mm. automatic cannon in the second, and the 37 mm. in the third, it will be readily seen that the intermediate class is highly desirable and that more of them are urgently needed for our present and future air force. The writer understands that the United States Government is interested in this type weapon; actually our ordnance experts have always been aware of armament developments all over the world, but they have not been in a position where they could advocate and procure such arms as they felt were desirable for our services. Our present defense program will doubtless permit them to make use of the best known types of arms known anywhere.

Probably the most advanced intermediate caliber automatic cannon are the Danish Madsen 20 and 23 mm. aircraft arms. The 20 mm. cannon can fire at the rate of 500 rounds per minute while the 23 mm. can fire at about 400



Inboard wing mounting of an aircraft cannon. As noted part of the gun mount extends underneath the lower wing surface and must consequently be faired in at this point.



Nose turret installation of a Madsen cannon in a foreign bomber. 1. Pivot point, 2. control level arms, and support, 3. ammunition magazine, 4. control handle, 5. Bowden trigger control, 6. elevation and depression control arm.

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rounds. The 20 mm. armor piercing shell can create havoc to any target which it hits, even penetrating inch thick armor plate, at 600 yd. Obviously, no airplane can be sufficiently armored against such shells. The 23 mm. is a special design that employs a shell with considerably greater effective explosive force than that of the 20 mm. while the weight of the 23 mm. cannon and complete round of ammunition remains the same as for the 20 mm. cannon.

A very novel and highly effective installation of Madsen aircraft cannon was made before the war by Fokker of Holland, in his twin-engined, two-seater attack plane Fokker G. 1. Two 23 mm. cannon plus two 7.9 mm. machine guns were fixed into the nose of the plane in front of the pilot's cockpit and within his reach. The 23 mm. cannon were supplied with belts carrying 100 rounds of shells each, and all the guns were loaded and operated by means of a combined pneumatic and hydraulic system. All the pilot had to do was to make his selection of what guns were to be fired on a selector switch board, and depress a lever when he wished to open fire. The ammunition belts for all the guns were of the flexible, disintegrating type made up of loose links, which fell into a container, as did the ejected cartridge cases, during firing.

A study of some of the salient characteristics of the weapons in the table lead to extremely interesting factual conclusions. The most important considerations of these aircraft guns in their order of listing, include weight of the gun, rate of fire, muzzle velocity, type of ammunition feed, type of ammunition, and weight of the ammunition to be carried.

Inasmuch as it is desirable to carry a number of guns on an airplane, the weight factor is quite a problem. Machine guns of either .30 or .50 caliber do not weigh so much, nor does their ammunition. A number of these could easily be carried by modern high-powered planes. But the machine gun has a tremendous disadvantage in using ammunition that is practically ineffective. The machine gun, however, has a high firing rate and a high muzzle velocity, which, however, does not assure flatness of bullet trajectory, as small arms cartridges start to curve very early in their flight.

The 20 and 23 mm. cannon compare very favorably with machine guns as to weight, although they do weigh somewhat more. Their firing rate is almost that of a .50 caliber machine gun, however. The type of ammunition feed is disintegrating belt, which means that a 23 mm. cannon can fire automatically as long as there is ammunition in the belt to feed it and installations are now available for 100 and more rounds of shells for these arms. They have a high muzzle velocity assuring a very flat curve or trajectory over distances such as would be common in aerial combat, up to 600 yd., although their actual effective range is much longer, as the table shows. The intermediate caliber shells are also very effective, and when fired from either fixed or flexible mountings, can be used against enemy ground objects, including gas storage tanks, and other targets which must be set afire or destroyed. This cannot be done with machine guns alone.

The increased explosive force of the 23 mm. shell is obtained by making the actual shell longer and the shell case smaller. The shell consequently contains more explosive matter, while the case holds less propellent. Due to this, the muzzle velocity is decreased considerably, giving the 23 mm. shell a shorter range. But as aerial combat takes place at comparatively short ranges, the only reasons why high muzzle velocity is desirable is to give the shell a flat trajectory, and also to reduce the time of flight of the shell. The latter is important, as every fraction of a second counts while aiming and firing, keeping in mind the many factors that combine to cause misses of both machine gun and cannon fire.

Practically all cannon armament on present day aircraft are mounted in either fixed inboard or outboard positions, with the exception of installations in large bombers and heavy flying boats. There are special types of small aircraft that do mount free guns in turrets, but these are all of machine gun caliber of .50 or less. The British Boulton Paul Defiant is an outstanding example of a super-armed fighter airplane, with numerous guns in the wings, fuselage, and a multiple machine gun turret aft of the pilot. The favorite position for cannon is in the nose of the plane, just in front of the pilot, though they are also mounted in the wings or slung underneath them. Planes such as the British Spitfire and Hurricane now carry four machine guns in each wing. These might conceivably be replaced by two cannon each. The total recoil force is felt in the plane but insufficiently to affect it either structurally or to change its flight characteristics to any great extent, under conditions where the guns are in fixed positions firing forward, inasmuch as the recoil is in the opposite direction in which the plane is flying.

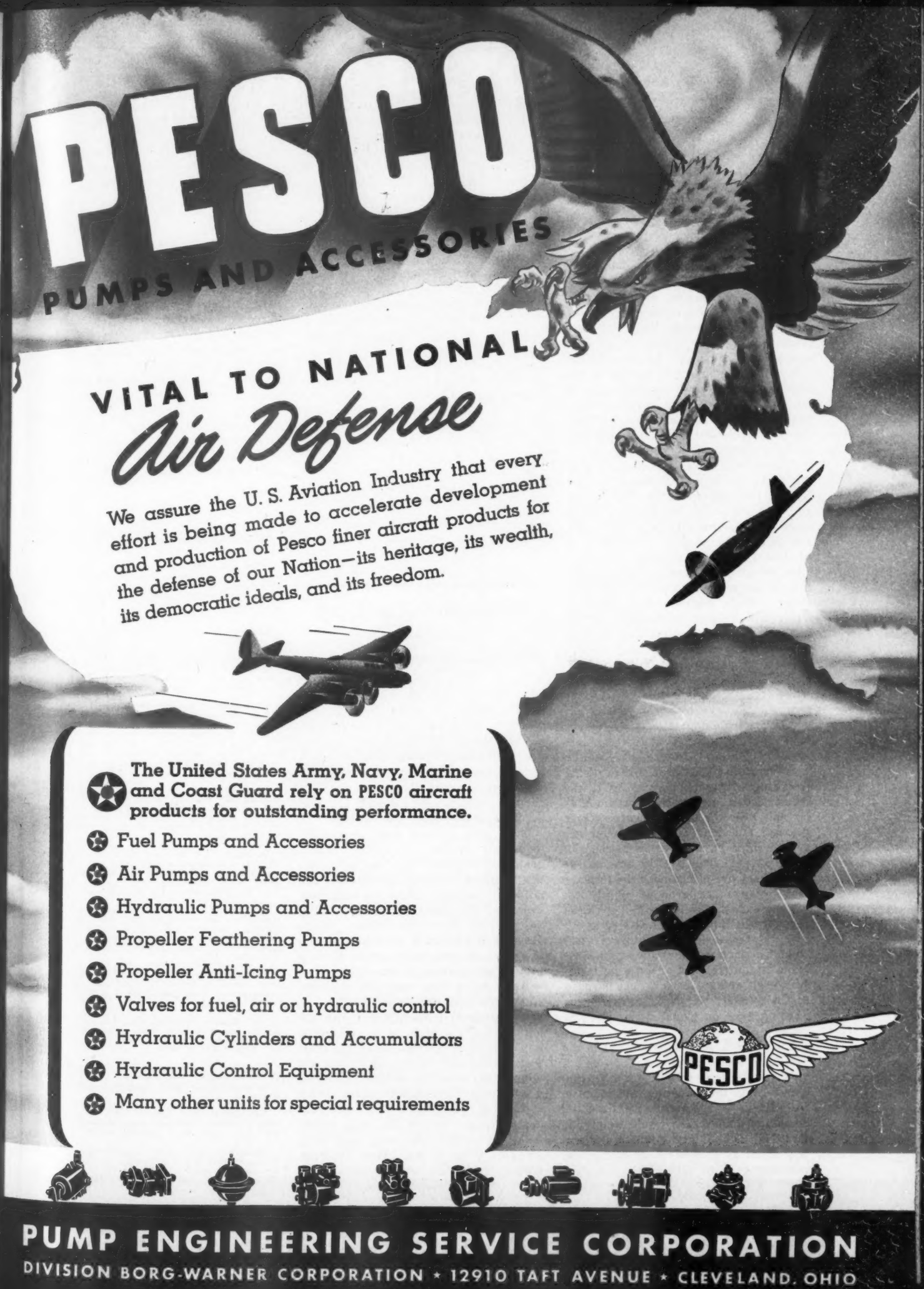
The effect of a 20 to 23 mm. shell on an aircraft fuel tank. Selfsealing construction, as used for protection against machine gun bullets, would be useless against this and larger types of shells

When these cannon, and particularly the heavy caliber 37 mm. cannon, are fired from free or turret positions, the effect of the recoil is much more noticeable and would actually hamper the maneuverability just at the moment when freedom from outside forces is most desired, i.e., when enemy planes are swooping down and around the defending craft.

The type of ammunition feed is an important factor although for fixed gun positions, an automatic belt made up of disintegrating links is more or less standard for both machine guns and cannon because it allows the feeding of a greater quantity of ammunition and because the belts can be fed from advantageous positions in the wings or fuselage and the boxes holding the cartridges or shells can be placed where most convenient. Nevertheless drums fixed to the guns have the advantage of giving a more positive feed than the belt type, which may lag or jam under violent combat maneuvers. Most drums will hold around 60 rounds of ammunition and up to 100 rounds, while belts can be endless up to any amount of ammunition that can be carried.

Among the types of ammunition are armor piercing, exposive, tracer and incendiary. The latter three are of importance in aircraft guns, with explosive taking the lead, the tracers being necessary for aiming control and incendiary to fire the enemy craft or ground objects. Referring again to the table (see item 15), it will be noted that the weight for 100 rounds of ammunition rises rapidly as the guns increase in size.

Designing airplanes of the fighter type to carry a maximum load of armament is far more difficult than heavily arming huge bombers or flying boats. The latter are structurally so sturdy that they can easily carry the weight of a number of guns in various turrets, and also withstand the combined recoil forces. The British and German fighters, however, are more heavily armed than our American planes. The British particularly have an advantage in owning high powered engines of 2,000 hp. and more, so that the plane and wing structure is designed to cope with speeds of 400 miles plus per hour.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Aircraft Cannon

(*Continued from page* 138)

The sketches show recent inboard and outboard wing mountings of cannon. There must be sufficient space allowed in the wing sections to accommodate the guns, their mountings, and the ammunition boxes. An inboard mounting is generally preferable, although it is more difficult to design, because it gives the fighter a smoother, and faster appearance, in keeping with the general streamlining principle. In some of the belligerent craft, the gun barrels do not even protrude from the leading edge of the wings, and the gun ports are covered with fabric until such time as they are fired in combat, when the coverings are blown away.

Reference to the table will show that the recoil force of the small caliber cannon amounts to about 400 lb. per gun. This is a considerable force which must be reckoned with in wing design, especially if more than one cannon is to be carried. Moreover, provision must be made for carrying the ammunition boxes with a sufficient supply of shells. With machine gun cartridge boxes now holding up to 1,000 rounds for each gun, it is evident that for cannon-equipped planes the shell supply must be proportionately large in order to obtain the necessary firepower and to be able to continue this power over long enough periods of time, so as not to be helpless against enemy fire, or have to return to their bases for reammunitioning.

Structurally the problem of wing mounting of cannon boils down to the principle of centering them as much as possible near the plane's own center of gravity, and that is why cannon are usually fixed in the nose or fuselage of twin engined planes. If set in the wings, they are placed near the fuselage and in any case grouped tightly together, with due consideration for head room for both gun and shell feed.

A prediction for the future is that cannon mountings in the wings will be made an integral part of the wing structure itself and so serve a dual purpose, and not merely be adaptations of fixing existing guns on planes designed to fly without these guns.

The 37 mm. gun characterized in the table for turret mounting only, has a surprisingly low weight for the gun alone. With the mounting, the complete installation would weigh 250 lb. 100 rounds of ammunition would weigh 164 lb. The rate of fire is theoretical, as fire is not as continuous as that of the machine guns or 20—23 mm. cannon, which are belt-fed. The 37 mm. cannon is fully automatic as far as the five round clip is concerned, but after each clip is exhausted, a new one has to be inserted manually by the gunner. To fire 100 rounds, he must insert new clips 20 times. To offset this, the 37 mm. shell is extremely effective and every one that would register against an airplane would almost certainly bring it down. The 37 mm. cannon we are here considering is for mounting on large bombers primarily and not on small fast pursuit planes.

Summarizing the three classes of aircraft arms in use, it is apparent that all have their sphere of action. Machine guns, it is evident, are becoming increasingly ineffective. The 37 mm. cannon projected for turret mounting is limited to certain types of planes, and for fixed mounting of this caliber cannon, using a longer gun with a higher muzzle velocity, would result in prohibitive weight of gun and ammunition.* The 20 and 23 mm. automatic cannon appear to be the golden medium, and indeed, they will play a large part in all future aerial warfare.

* Unless used as the only fixed gun on the plane, or at most two on twin-engined and larger craft.

Acrobatics Are Easy

(*Continued from page* 134)

wing, have them filled. If you can use a metal prop instead of wood, that also helps tremendously. Another valuable aid is to start the maneuver gently; that is to allow the wing to drop only a little at the start. By using all these aids, together with the proper delicacy on the rudder, you should be able to do a pretty good falling leaf.

Now, with at least 3,000 ft. of altitude, let's try one. Close the throttle gently but don't let the nose drop. Set the stabilizer adjustment to the full tail-heavy position. *Ease* the stick back *slowly* as the speed decreases, holding the nose just above the horizon. When the stick is hard back, give just a touch of rudder on the side you want to drop first. Let's assume it the right.

As soon as that wing starts down, apply light opposite, or left rudder. If you have been quick enough with the left rudder, the right wing will drop not more than 30 deg. Hold the pressure on the left rudder until the right wing comes *almost* to the level position. Then apply right rudder again, being careful to hold the stick hard back continuously. Before the right rudder takes effect, the left wing will drop, probably about 45 deg. Hold the pressure on the right rudder pedal until the left wing comes up *almost* to the level position, then apply left rudder, and so on.

You will find that the wings will tend to drop further and further each time, and that more and more rudder must be used. The most important consideration in executing the maneuver properly, and holding unchanged the direction in which the ship is pointing, is the timing of the rudder. If this is as little as a half-second off, the ship will probably get away from you, the nose will swing, and the whole maneuver will be spoiled. Also, as mentioned before, the stick must be held hard back against the stop, but must be brought there gently. If the nose is pulled up too high at the beginning, the oscillations are likely to become more violent right from the start, requiring much better timing and more careful application of rudder pressure to hold the ship on course.

In the next part of this series we will take up the real acrobatics.

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Rear Engine Installation

(*Continued from page 47*)

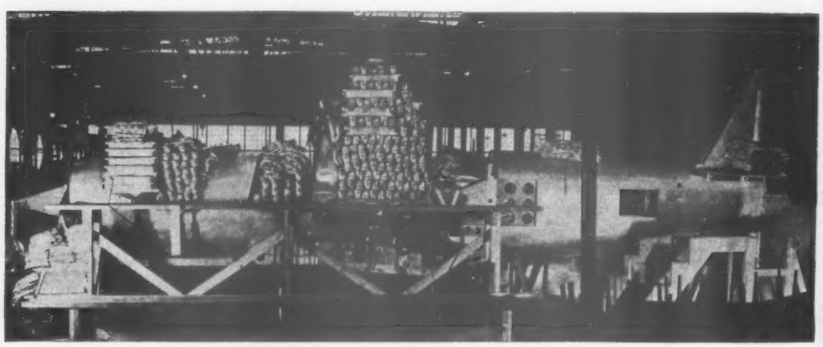
corporating an ideal nose shape and a cleanliness of fuselage contour never achieved on an airplane of the P-39 type with the engine installed in the nose. The problem Bell Aircraft was faced with was to provide a sufficiently light and satisfactory structure. It was necessary to support the independent reduction gear box and propeller on the nose, the armament installation, the retractable tricycle gear, nose wheel, the pilot and his cockpit equipment and to connect together the airplane wings and tail besides adequately hooking up the power plant components. It was decided to build what constituted essentially the front half of the fuselage as a stressed skin, sheet metal platform incorporating two main longitudinal beams. These beams were continuous from their attachment to the propeller reduction gear box back through the gun compartment, under the pilot's cockpit station and under the engine to connect to an oval monocoque rear fuselage assembly which carried the tail surfaces. A top deck over the beams constituted the floor of the cockpit and the gun compartments and the engine bearer rails were attached to the top of the beams where they passed under the engine. Transverse beams in this platform provided the wing carry-through from the two detachable outer wing panels. The tricycle gear nose wheel was attached to the two longitudinal main beams of the front fuselage section and retracted by folding aft between the beams. A very desirable arrangement for accessibility was possible in having the upper portion of the fuselage above the beam section constructed principally of removable cowling. This arrangement permitted the manufacture and installation of the complete pilot's cabin as a unit assembly and made possible the use of large automobile type doors on each side. It also permitted unexcelled accessibility to the engine installation. Facility for such work was increased because the engine was so located that the wing could be used as a working platform by the mechanics. By simple disconnection of the 6 bolts in the extension drive shaft flange the engine could be removed by being hoisted directly from its support on the longitudinal main beams without disturbing the propeller or armament installations, an important time and trouble saver. An accurate and complete mock-up was made and these conditions were checked and the opinion of all concerned was that the accessibility and conditions for simple and improved installation was in excess of anything available in comparable airplanes of the conventional arrangement.

A careful analysis of this structure indicated that satisfactory light weight strength and rigidity could be obtained. There were, however, as has been mentioned, certain problems as yet unsolved. One of these was the fact that the airplane fuselage beam assembly was to all intents and purposes a part of the engine assembly since it was really a crank case extension and acted as a housing and support for the extension drive shaft and independent gear box assembly and propeller. It was, therefore, obvious that the transmission of power through the shaft would impose not only certain torque loads on the fuselage beam structures, but would also subject it to critical vibration as it occurs in many phases in a high power aircraft engine. It was also obvious that the engine would induce these torque and vibration conditions on the fuselage structure at all times and for all conditions of flight including when the airplane structure was loaded to design limits by the air loads of prescribed maneuvers. Therefore, many calculations were made and numerous physical tests were instigated to check the vibration resonance period around the vertical, lateral and rotational axes of freedom to insure that no resonance would occur in the airplane structure that would prevent satisfactory function of the engine shaft drive or unrestricted use of the airplane. How well this work was done is borne out in the final flight and ground tests of the airplane, where the only resonance that was found for any condition of operation was a local vibration in a sub frame at the cockpit doors that acted up in flight at 2,200 r.p.m. engine speed. This small item was quickly modified to eliminate its case of St. Vitus dance.

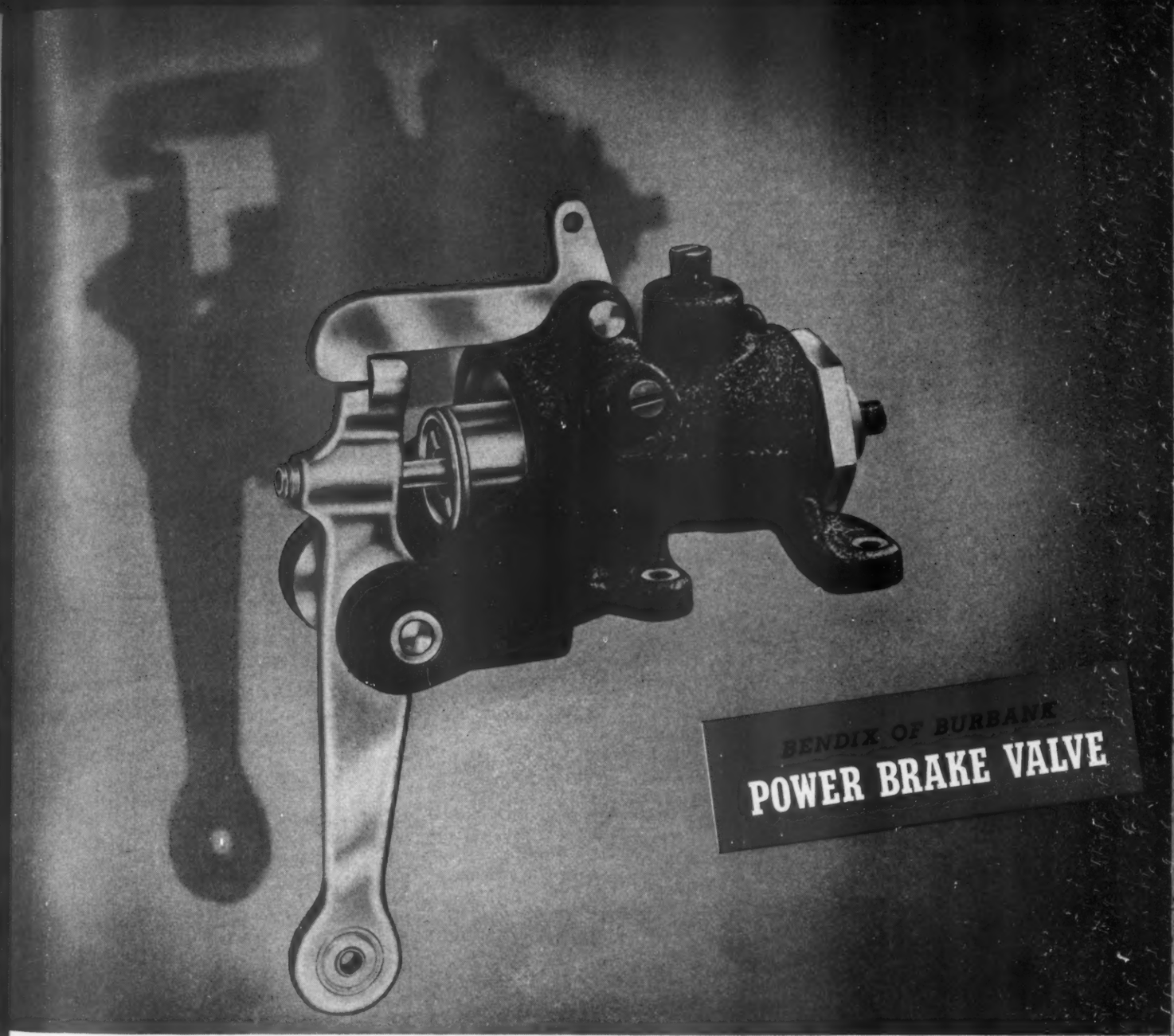
The Allison Engineering Co. converted their designs to metal as rapidly as possible, and within a few months after the beginning of this development work produced a complete engine shaft and gear box assembly test set-up. A special support was built on the test stand at the Allison plant to support the extension shaft and propeller drive gears in a manner that would simulate the conditions of support as they occurred on the actual airplane. This supporting structure permitted the forward end of the extension shaft to bounce to the vibrations induced by the propeller and torque with a total vertical amplitude of about 3¼ in. which would correspond to the maximum deflections that would occur in the airplane structure under the full design load. Very complete and exhaustive tests were run on the drive shaft at the Allison plant and during these tests the entire drive arrangement was run for considerable length of time at horsepower ratings well above the 1,150 hp. normal rating established for this equipment, the peak being close to 1,400 hp. At one time during the engine tests the gear box at the forward end of the extension shaft was deflected 1$\frac{15}{16}$ in. out of line and held in this position for 20 hr. of engine testing at full power. A more severe test for the flexible drive connections and operation of the shaft under a difficult condition could not have been devised. In some 300 hr. of test stand running and approximately 110 hr. of flight test of the engine drive shaft and gear box units only one minor difficulty occurred which required change.

Due to the circumstances it is believed that a case history of this minor difficulty should be told here. With the magnitude of this development project and the interest evidenced in it, all the testing was conducted under extremely high pressure. All of the

(*Turn to page 144*)



The Airacobra undergoing static tests. Because of its engine location, the fuselage was designed to carry an extreme bending load.



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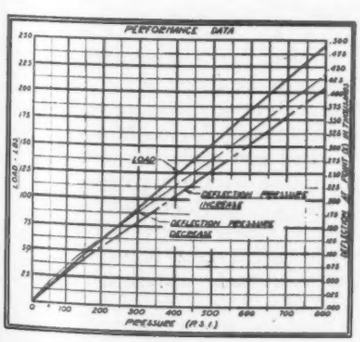

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Rear Engine Installation

(*Continued from page* 142)

engine tests were watched with an extremely critical eye by the engine manufacturer, the Army Air Corps, airplane manufacturer and aviation industry at large. The trouble which developed in the engine occurred in a quill drive shaft located in the accessory drive section of the engine. This quill drive shaft was a new mechanism that had not been used in any previous Allison engine and was part of the modification of the basic engine design to permit the use of the extension propeller drive shaft. Due to the unfortunate limitations of standardized technical nomenclature the engine accessory quill drive shaft was none the less a drive shaft and could be and was readily confused with the extension propeller drive shaft although no similarity of function or design existed. The quill shaft trouble was readily tracked down and determined to be a condition of flutter that occurred in the small spring quill accessory drive shaft. At idling engine speeds the fly wheel effect of the rotating mass of the engine crank shaft system was inadequate to prevent the torsional resonance of the extension propeller drive shaft from deflecting through to the accessory drives. A simple dampener mechanism attached to the quill shaft eliminated the trouble but the damage had been done. The aircraft industry grape-vine carried the news that the Allison extension drive shaft engine developed for the Bell P-39 was having shaft trouble. Three years later it is still not uncommon for representatives of Allison or Bell to be queried as to whether the extension shaft trouble was ever completely overcome. The true story of the shaft trouble is that the propeller extension shaft drive has never given a minute's trouble or displayed any undesirable functional characteristics whatsoever and that the small quill accessory drive shaft in the engine has been properly fixed and is operating satisfactorily. The story of the shaft trouble is told here in the hope that it is no longer news.

As has been stated before, the development of the extension drive shaft installation was the major problem to be solved in the construction and development of the P-39 Bell Airacobra airplane. All of the ability, research and test facilities of the Allison Engineering Company and Bell Aircraft Corporation were concentrated on the solution of this one basic problem and the satisfactory results obtained from the installation must reflect to some extent the effort placed on this development work. The extension drive shaft installation is, however, not the only development and innovation incorporated in the P-39 airplane.

Other new innovations, one of which was submerged cooling, were also incorporated in the Bell P-39 airplane. "Submerged cooling" is a technical term that describes an arrangement wherein holes are provided at suitable points in a basic airplane component, such as the wing surface, through which the air required for cooling the power plant is taken in and discharged. Internal ducts are provided to conduct the cooling air from the entrance hole to the exit hole and the radiators or other heat dissipation equipment are located in these internal ducts. Since the fuselage shape itself had been made to a true streamline form of optimum aerodynamic efficiency it was believed undesirable to destroy this condition by the addition of numerous scoops and ducts and external appendages such as were normally used to house the radiators and conduct cooling air to and from them. A large amount of basic research work had been done by the National Advisory Committee for Aeronautics regarding possibilities and desirable arrangements for submerged cooling and for proper design of internal ducts in the airplane wings. An early phase of this arrangement had been used very successfully on the Bell Airacuda and it was indicated that the large amount of cooling air required could be obtained with minimum effect on the aerodynamic characteristics of the P-39 airplane by taking cooling air in approximately at the stagnation point of the leading edge of the wing and expanding the duct internally to the prestone and oil radiators and by providing a converging duct aft of the radiator leading to a discharge located at or near the trailing edge of the wing. From tests made on models and from design data available from NACA this arrangement for cooling was included in the airplane and is no small contributing factor to the superior performance of the P-39.

Another of the innovations in the airplane was the inclusion of the 37 mm. automatic aircraft cannon of the type developed by the U. S. Army Ordnance Department suitable for firing 37 mm. explosive projectiles at 2,000 ft. per sec. muzzle velocity at a high rate of fire. This gun, weighing close to 200 lb., had been developed for the use of our Army as an anti-aircraft defense gun, and was at one time, not too long ago, considered too large and powerful to ever be carried by small fighting military aircraft. On the Airacobra the arrangement and equipment and facilities for mounting and carrying guns permitted the design of a proper placement and support and location of the gun and feed mechanism so as to permit its installation. The carrying of this powerful weapon, precedent for which has been only established in the Bell Airacuda, a large, twin engine multi-place fighter which carries two of these guns, is an important factor in providing increased fire power. Installation was also made in the isolated forward gun compartment of the P-39 fuselage to install two .50 caliber and two .30 caliber aircraft machine guns in a very compact, accessible and satisfactory manner. These five guns grouped closely on the pilot's line of sight at the centerline of the airplane provide a concentrated mass of fire power that is believed to be the greatest carried by any single place, single engine military airplane in the world. The arrangement of the airplane and the gun installation is such that a 20 mm. cannon of extremely high power firing explosive bullets may be substituted for the 37 mm. cannon where it is desired to have higher muzzle velocity and a more rapid rate of fire with somewhat smaller size explosive projectiles. Provisions have also been made in the airplane to install four .30 caliber machine guns in addition to the other armament in the wing panels outside the propeller disc, to provide an increase volume of area fire in addition to the concentrated fire power located in the fuselage.

The placement of the pilot ahead of the engine in his little "office" located near the nose provides some innovations and visibility not heretofore realized on single engine tractor military aircraft. The vision provided for the pilot is excellent in all directions. So-called fighting vision for the pilot in the area forward and down is a very important consideration. Vision in this area is provided on the P-39 equal to that obtained in most twin engine airplanes and is a very desirable feature. There are numerous other innovations in detail design of the airplane which are beyond the scope of this short discussion; the use of magnesium alloys for certain parts of installation and construction permits a saving in weight and reduction in size of the airplane to a minimum, the completely tested and developed tricycle gear added much to the safety for operation and utility for the airplane, certain aerodynamic developments in the design of the wings, wing flaps and surface control system, make the Bell P-39 Airacobra a completely modern and distinctly advanced military airplane with great speed, exceptional facility for maximum utility and extremely powerful fire power. It is indeed a development in which all who have done their part should feel proud.

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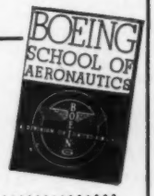

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Plant Layout

(*Continued from page* 49)

must be brought into being by a creative process. The layout engineer should among other things be able to bring to bear knowledge of plant construction material handling, manufacturing processes, production control, management coordination, methods analysis and office organization. The real substance of an industrial expansion must come from men who are accustomed to dealing with the specific problems in the industry from which the new expansion is taking root, from men who can speak from experience about the work of their departments or those under their supervision.

In connection with operating departments methods time-studies were mentioned. The changes or improvements indicated, as well as the operation flow charts, should be ok'd by those who will be responsible for those operations when the new set-up gets under way. If there is a separate unit charged with determining the selection of new equipment, it will naturally make decisions of this kind, but again there is much to be gained by having those who will later be responsible for operation contribute their suggestions.

In the field of material handling, covering receiving, storage and shipping, there is a wide range of possibility offered from the experience of industry as a whole, but here again those charged with handling the work in the present plant may have much of value to suggest in the development of methods best adapted to the new unit.

This principle holds true in the planning of new offices, both as to equipment and arrangement. Flow charts are valuable here. One particular item might well be mentioned. There are many reasons for traffic from outside offices being planned so that people do not stream past clerical workers to reach executives, contact clerks etc.

In manufacturing or shop operations many gains achieved in a new layout come from a careful study of physical conditions. A balance must be arrived at in the allotment of working spaces. Crowding is bad, but time and effort expended in excessive walking about eats into the work which a man can accomplish. This is especially true if he has to carry something during such movement.

If parts can be handled without lifting, the man-hours per part are correspondingly reduced. If a man can do his work without bending over or reaching up, his effort saved, multiplied by the number of men on the job, will build more airplanes.

Adequate lighting will have as much effect as any other factor in getting out satisfactory products and in maintaining the vigor of the men. The problem of lighting is a difficult one to solve, but one principle seems to be cardinal. Every effort should be made to prevent glare. This applies to bright light reflecting from working surfaces into a man's eyes, which interferes with his work, and to glare spots from light sources shining in his face when he looks up from his work or has to move about. It is wasteful to spend good money to develop equipment or methods for increasing production only to lose part of the gain through poor lighting. It is expensive, and poor labor relations, to spend large sums hiring and training men only to spend money over again when eyestrain contributes to labor turn-over.

Noise is another factor to be considered. Some work must be noisy, but there is no reason why more quiet departments, where men are trying to concentrate, should be blasted by noise. Both by proper location and through the use of curtain walls, much can be accomplished which will improve the working condition and bring real dividends. The fact that the office is usually well insulated proves that somebody believes that noise prevention has merit.

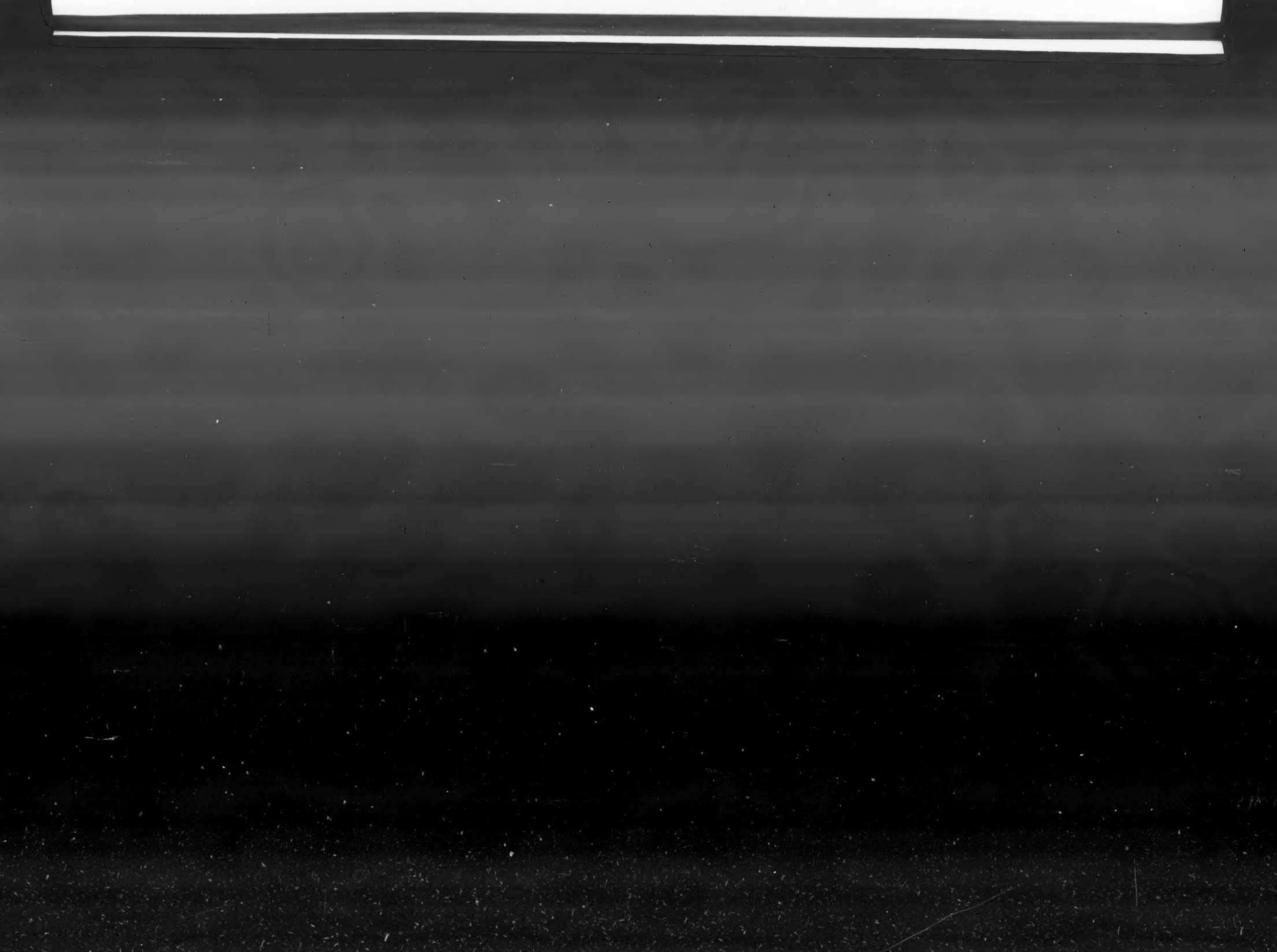
The subject of heating, ventilating and air conditioning is in some respects similar to the subject of noise. When a man's fingers are stiff he doesn't handle things with normal dexterity, and if his body is cold he doesn't loosen up by thinking about it. If he must hold a given position at work he can't warm up, and if he dances about, he isn't working. Also for another reason, the work falls off when it is too hot, some say 35 percent when the temperature rises over 90 deg. To build more airplanes in as short a time as possible, adequate heating, ventilating and air-conditioning are beneficial. As a matter of morale, such provisions are worth considering. As a matter of dollars and cents there are data showing them to be good investments. The question as it affects layout might be said to be extraneous and the policy involved is a matter for higher-up decision. But the location of facilities for such purposes can affect departmental layouts, especially if ducts cast shadows, cutting off lights from sawtooth, monitor and wall window surfaces. While in turn the disposition of heat-making machinery and the numbers of employees in departments have important bearings on the economy of layout of heating, ventilating and air-conditioning systems.

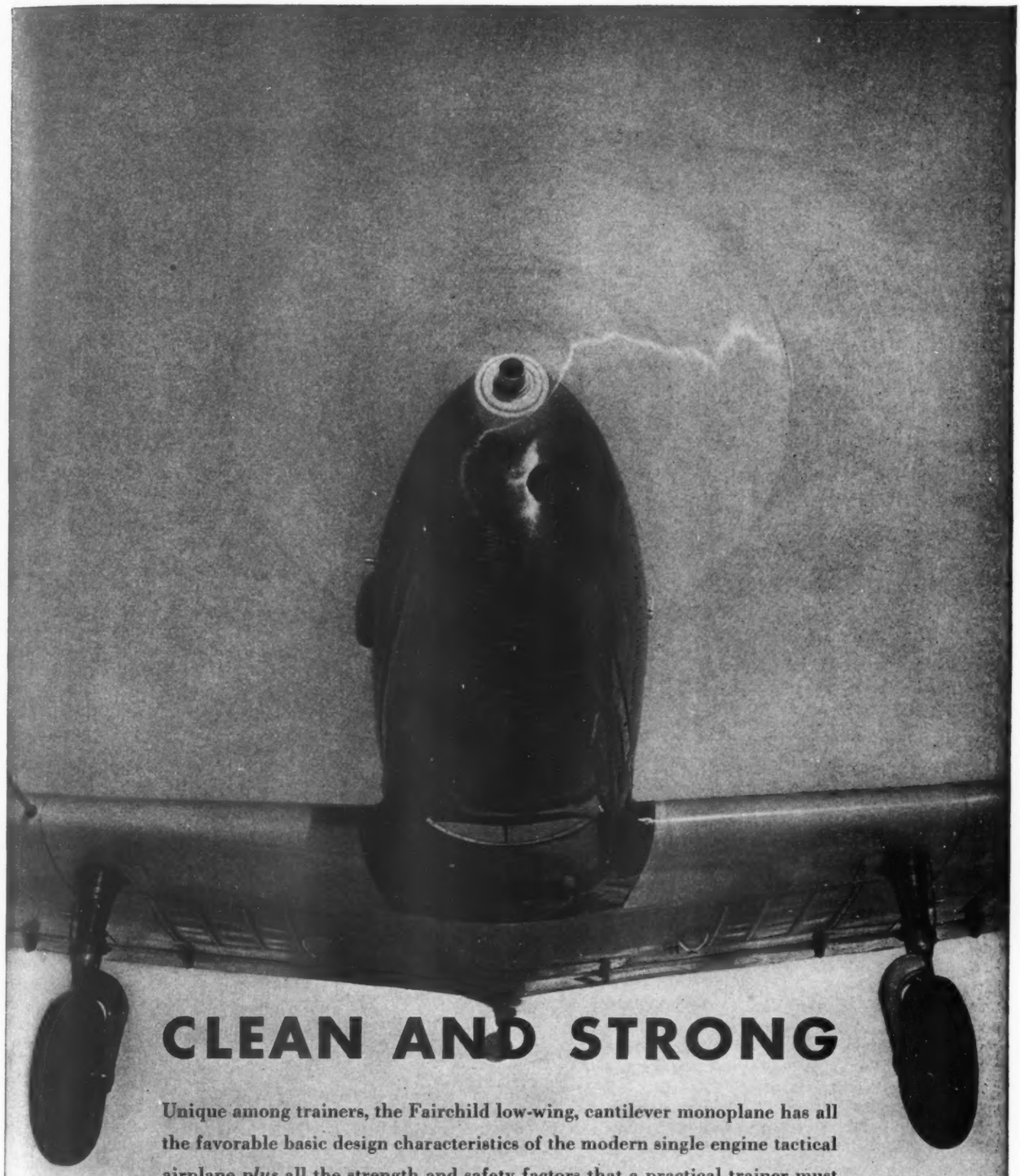
No study of layout is complete without some consideration being given to possible later expansion or changes. Theoretically, the simplest provision for later expansion is to make room for building new units or extensions to house various processes. Where a plant is laid out as one continuous straight line, and expansion can be had by growth of each department sidewise, such a scheme is almost ideal. But this is not always practicable. Changes of type or design of product which the market may demand are likely to affect directly the floor areas given over to assembly and fabrication departments, to change their proportionate areas, and to require the addition of new departments. Where the shape of the building or buildings has already been determined in advance of layout, the operations may in plan follow other than a straight line progression. Fabrication departments may feed out to assembly lines flowing crosswise past them. Enclosed departments may need room within themselves for rearrangement and expansion as equipment undergoes improvement or the demand for given processes increases. But as far as possible the layout engineer should try to leave for each department unobstructed space into which to expand by future building additions. If the problem is limited to making the best full use of an existing building with no expansion possible, the layout of course is narrowed down to that of creating the most efficient operation within that space.

Handling Traffic

Traffic is another major layout problem. The widths of traffic arteries should provide for the volume of men and material to be handled. In general, the greatest streams of traffic within the plant should be made to traverse the shortest distance. Traffic outside of buildings today calls not only for adequate sidings, truck driveways and storage spaces, but the necessary provision for parking employees' cars.

In addition, traffic should be looked upon as means of communication. If men have to converse, send messages or otherwise get in touch with each other, if no other means are available, somebody has to walk somewhere. In a large modern aircraft factory one can walk miles in a day. Without communication devices much of the time of hundreds of people would be spent walking around, which cuts down the time of doing work or making decisions, and slows things down. Hence a study must be made of the need for telephones, signals, message conveyors and other equipment, and the traffic volume and locations of communication devices diagrammed and built into the plant layout.





CLEAN AND STRONG

Unique among trainers, the Fairchild low-wing, cantilever monoplane has all the favorable basic design characteristics of the modern single engine tactical airplane *plus* all the strength and safety factors that a practical trainer must have. Note the aerodynamically clean lines of the Fairchild M-62. Note also the wide-set, simple but rugged landing gear built to withstand the *extra* rough usage and bad landings inevitable in today's accelerated training programs.

FAIRCHILD AIRCRAFT

Division of Fairchild Engine & Airplane Corporation
Hagerstown, Maryland . . . Cable Address "Faircraft"

Similar study should be given to other services. Washrooms must be provided. Timekeeping units must be strategically located. First aid rooms must be readily available. Clockhouses and exits are important to consider with relation to the departments they must serve. The location and design of stockrooms is essential. Toolrooms and toolcribs must be conveniently placed no matter who obtains the tools for the work. Production control units must fit efficiently into departments. In fact the general scheme of routing and planning, together with questions concerning the centralization or decentralization of production control, are largely influenced by the ramification of operations and the degree to which the work is spread over a large area. All these services gain by forethought in the original layout. Putting them in later as afterthoughts means the multiplication of clerical help as well as an additional expense.

Safety is another factor which creeps into the problem of layout. Hazardous processes should be carefully planned. Men working at them should be free from distraction by passing traffic. Men on machines and benches rarely need to work under moving cranes or other workmen who might inadvertently drop parts or tools. Projecting equipment, or unshielded machines splashing oil on the floor, must not be placed where men who must walk or work near them can be injured. Others should have no access to operations where explosions or other accidents can harm them. Men should be railed away from charged electrical equipment and their machines or work places kept at a distance. The safety engineer will build safety into the machines in the departments. But the layout engineer must build safety into the operations as a whole.

To return to the diagrams or flow charts by means of which the movement of material progressively through the operations is studied and organized, it should be pointed out that it is here that certain accessories to the work should be considered. What size of table or bench does the machine operator need for layout, or parts, or his own tools? What provision should be made for spreading out large blueprints? Will raw stock be delivered on wheeled tables or in tote boxes or how? If the work is bulky how much space will be required before or after operations? What means are necessary to keep workplaces clean? How much energy will be saved for the work if a man can sit down during certain stages of his operation, and how can this be provided for without taking up too much space? What provision must be made for hoists, roller conveyors, lifts, etc.? If a man can run more than one machine what is the best combination arrangement? Which machines need the most frequent supervision or attention by inspectors, and therefore, should be most accessible? Which machines are likely to make the most extended runs, which require the most frequent replenishment of stock, which are more often dependent upon toolcribs?

It has taken millions of years for nature to evolve such complex organisms as men and animals, and the laws and purposes of nature are very definite, the process of adaptation very gradual. In a sense man has dreamed and been evolving the airplane in a flash of time. He has dreamed and been evolving the tools of industry with which to make it, in but another flash of time. Yet war has forced him to try to go still faster. Whether the problem be the layout of a job shop, a parts fabrication and assembly shop or a whole airplane factory, it may be worth while to recognize it as a kind of synthetic evolution by means of which the cooperative contributions of the experienced key men, trained technicians, and engineers available are put through a rapid process of adaptation and creation to the end that the normal growth of a generation be applied to the immediate need of the industry to produce quick results for the national defense. *(In a future issue Mr. Parsons will discuss ways of increasing production through control methods and incentives.)*

Direction Finder

(*Continued from page* 43)

successful commercially. The final unit which is now being redesigned to be placed into commercial form has never given an inaccurate bearing greater than 7½ deg. This direction finder resorts to a device invented in 1908 but which was discarded because it was not highly satisfactory for use with long-waves (then the only waves in common use) and (in-sensitive) receivers. This direction finder incorporates in it every known principle of direction finding which has been learned (largely by the English) in the past 25 years of direction finding research. The direction finder consists of a receiving unit which must be located clear of all power wire, wire fences, etc. This unit has attached to it the directional array. From this directional array comes a pair of telephone lines to the dispatch office where the control and indicating unit are located. The control unit can place the direction finder in operation by using the same pair of telephone wires which brings back the bearing indication. The bearing is recorded on a piece of paper each time that the pilot turns on his transmitter. These papers having the bearing marked on them may be filed for future reference in case they should ever be needed.

The device compensates for the following effects which can produce errors:

1. Wave polarization
2. Diversity
3. Capacity coupling
4. Layer oscillation

In addition to the above the secret of the accuracy obtained is a positive means for identifying false bearings. The only means for detecting false bearings which have been used in the past were for the operator to discard those bearings which to him sounded "hollow". Obviously only an operator with long training can tell whether a bearing has a "hollow" sound. This direction finder incorporates an indicator which very definitely gives the quality of the bearing.

Now the question arises as to how this direction finder is to be used. Only one of these direction finders will serve to give a line bearing but no position. Two bearings not in line with each other must be obtained if the location of a plane is to be known. Multiple bearings giving the location of a plane may be obtained if the airlines incorporate and install these direction finders in order to take bearings on each other's planes and transmit them by wire. The government can of course install these direction finders and furnish a service to the airlines as well as to the itinerant flyers. Even if this is not done an airline can install direction finders at its terminals and the line bearings obtained will serve a useful purpose to the dispatcher. When a plane has deviated from its course the dispatcher immediately knows even though he does not know where the plane is actually located. If an airline operates over airways which do not form a straight line but intersect at some angle, bearings can be taken from the various stations and be transmitted to the control station every time a plane transmits. Of course, an airline can locate stations at strategic positions but this is rather an expensive procedure. We are not certain at this time just how we will use these direction finders, but feel that even the line bearing which can be obtained from a single, simple installation will be of great help in assuring the safety of aircraft in flight. By using the system and techniques described it is believed that the dispatcher will know that the plane has not deviated from its true path.

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TRADE MARK

Harvey Directional Control

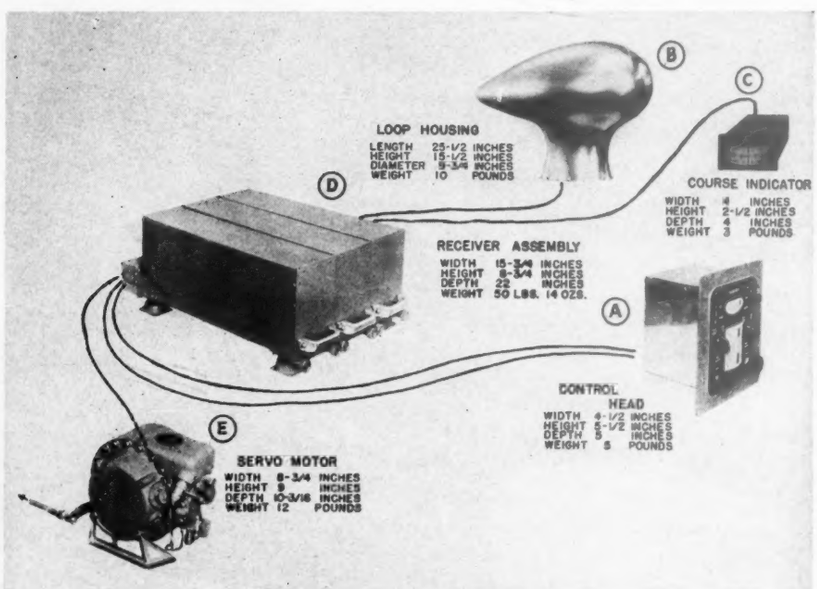
(*Continued from page 53*)

are no longer equal, the signal from one station will overbalance the other and, by means of a thyatron tube control, suitable correction is applied to the rudder through the servo motor.

Following a long period of flight testing with laboratory equipment, a production model of the Harvey control is now being manufactured on order. It will be obvious to the reader that this control has the widest possible application in both scheduled and non-scheduled civil aviation, and in military flying. While the Harvey control is now much too expensive for the ordinary non-scheduled flier, it is well within the financial reach of airline operators. Weight is not a serious problem in either case, as the complete installation amounts to approximately 80 lb., although some of this equipment may be standard. For the non-scheduled operator it will become obvious through a brief study of a map showing commercial broadcasting stations of North America, that there is no spot very far from a straight line intersecting two convenient stations. Especially is this the case in view of the demonstrated range of the Harvey equipment of well over 1,000 miles. Incidentally, strength of signal is no problem in tuning the set, since tuning is done by meter, rather than aurally.

For the airline operator it should be a simple matter to set up special radio signal stations if desired, although this is obviously not necessary in view of the fact that all cities and towns served by airlines are also served by one or more radio broadcasting stations.

From a military standpoint the Harvey control has wide implications. Through use of portable broadcasting sets placed with mathematical accuracy so as to direct a course to any desired target it is possible to reach that target automatically regardless of visibility. The amount of fuel conserved through improved accuracy of navigation would be a vital factor in connection with much bombing activity. Furthermore, by setting up a second line of control, intersecting the navigation line on the desired target, it is possible to incorporate automatic bomb releasing. While such bombing would necessarily be of "area" type, rather than selective, it should be highly effective in directing attacks against an entire city. Accuracy of such an operation could be greatly aided by observation under conditions of favorable visibility, and appropriate correction of the radio control station locations. A further interesting possibility is the directing of entirely automatic "flying torpedos" by this method, employing no crew at all.



Schematic installation of the Harvey Directional Control, showing (A) control head, by which course is selected; (B) loop housing to pick up radio signals; (C) course indicator; (D) receiver assembly coordinating signals governing; (E), the servo motor which, attached to rudder controls, holds plane to the desired course.

Engine Suspension

(*Continued from page 63*)

with the mount to reduce vibration in the plane?" This is a modern version of the same problem which man faced when he first hitched a horse to a wagon. The horse did not move forward as a rigid unit. In moving his legs he moved one shoulder forward faster than the other. Then he reversed. The center of gravity of the horse advanced quite steadily, but the man had no way of hitching on to that. Even in that early day a vibration specialist must have been on the job. His invention, the whiffle-tree, is still in use today. But a vibration specialist is a practical cuss with no sentiment whatever. Do you recall his brain-child, the whiffle-tree (see sketch —Fig. 2), and the job he gave it?

A good example of the conventional type of flexible mount is shown in illustration No. 1, a Condor mount. This mount had a great deal of flexibility in all directions, but it permitted the weight of the engine to cause droop: that is, it was "coupled", decidedly so. At first glance, "coupling" seems a necessary evil. But let's see what dynamic suspension does with it.

Dynamic suspension prevents droop (coupling) by giving the equivalent of support in front of, as well as behind, the center of gravity (Fig. 3). When this is done to just the proper degree, the tendency to droop disappears and does not reverse itself. Then shake remains purely shake, producing no pitch or yaw, and is "decoupled".

Now what becomes of the tendency for one of the points of support (mounting lugs) to move forward while the opposite one moves back (movements which are part of pitch and yaw)? Like the whiffle-tree, the links of the dynamic suspension mount permit this relative motion without transmitting the tendency to move. Also like the whiffle-tree, they hold the proper relationship of the power unit as a whole.

Fig. 4, upper half, shows vibratory motion in the pilot's seat, (actually recorded). Note the motion present with the conventional mount—more than twice that which occurs with dynamic suspension. The lower half of this picture shows how dynamic suspension reduces vibratory stresses in a motor mount member. Note too how the vibratory stresses, which peak at objectionable rpm within the operating range with the conventional installation, are consolidated at rpm in or near the idling range when dynamic suspension is used.

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In Volume Production for the U.S. Army Air Corps & U.S. Navy
Ryan
ST TRAINERS

Cost of Private Planes

(*Continued from page 35*)

for fire losses on the ground, to a $25 deductible or at the assured's option to a $50 franchise clause, 20 percent self-insurance for losses on the ground and from 20 percent to 33⅓ percent, depending on the experience of the pilots, for crash losses. In recent months the deductible or franchise and ground self-insurance can be eliminated for an increase of $1 per $100 of insurance. When a plane is purchased on time the finance company generally requires one of the light plane plans with an extension to protect its own interests.

The rates range from $3 for each $100 of valuation for the coverage on the ground, $13.25 if the air hazard is included and $10 or $11, depending on whether the insurance is on a named perils or all risks basis, for the light plane plans. The rates, except for the light plane plans, are higher where an airplane is used commercially because of the greater risk brought about by the plane being flown much more extensively. Obviously this subject requires individual attention and makes allocation difficult. For our purposes we believe a reasonable allowance should be between $100 and $300 per year.

4. *Hangar Rent.* It is probably good economy to keep planes under cover, although one frequently sees them staked down outside and more or less covered with canvas. Our inquiries show that hangar rent varies from $7 per month to $12 or $14 for small planes.

Operating Costs

1. *Gasoline.* Gasoline consumption is, for a given plane, a function of the engine horsepower and cruising speed. The cost of gasoline varies widely, and this cost must be adjusted to local conditions. Most states do not tax fuel used in planes. This often amounts to a saving of from 4 to 8c. on a gallon. High-octane aviation gas costs 5 to 8c. per gallon more than automobile fuel. Some of the light-plane engine manufacturers are now recommending for their engines the so-called "blended fuels," which obtain their antiknock qualities without the use of tetra ethyl lead compounds. The use of such fuels is desirable for economy, and further savings are possible where it can be purchased in drums or in larger quantities.

2. *Oil.* The best oil is cheaper than engine repairs, and it pays to use it. Manufacturers' recommendations should be followed, but complete changes are probably not necessary oftener than every 50 hr. of operation.

3. *Engine Upkeep, Including Propeller.* Engines for light planes are continually being improved along the lines of better weight-power ratios, greater dependability under adverse conditions, and more economical operation. There is some variation in the cost of maintenance with engine horsepower, but, among the engines available for light planes, there is more variation with the individual job than with the horsepower. Recommendations for engine care differ considerably, but the following suggestions and estimates for each 1,000 hr. of service are conservative:

Two-top overhauls, at 400 and 700 hr., at $25	$50.00
One major overhaul, at 1,000 hr.	100.00
Magneto and carburetor with associated parts—repairs	35.00
Propeller	15.00
Engine cost per 1,000 hr	$200.00

The cost of maintaining the propeller should be small, so that the above estimate allows something for accidental breakage.

4. *Plane Upkeep.* Upkeep of the ship usually costs less than the engine upkeep. Estimates are again based on 1,000 hr. of flying and include:

Inspections by licensed mechanic	$50.00
Paint—every two years	25.00
Controls and landing gear, including cables, bushings, etc.	15.00
Tires and tail-skid or wheel	25.00
Pyralin and fabric replacements	20.00
Seats and upholstery	8.00
Instruments	7.00
Plane cost per 1,000 hr	$150.00

5. *Minor Accidents not Covered by Insurance.* Unless the most expensive type of insurance against loss or damage to the plane is carried, the assured must share in the cost of accidents. The amount of this participation varies from $25, deductible for each accident, to as much as 33⅓ percent of the total damage. The most satisfactory way to allow for these minor accidents or for participation in the major ones is by adding an arbitrary amount to the running costs of the plane. It is suggested that for this purpose 10 percent be added to the operating costs, unless the plane is totally insured.

Field or Airport Expenses

Small private flying fields are not usually practicable. Where the use of fairly level, cleared land may be secured for less than $5 per acre, per year, the establishment of a private airport may save both money and time.

All costs connected with flying fields are high and among the items to be considered are: fitting and care of runways, roads and parking areas, fencing, hangar facilities, including shop, heat, water supply and plumbing, telephone and supervision. Even the simplest "T" type hangar will cost close to $300.

It is well to remember that old barns have sometimes been converted into hangars at small expense. Good will is worth its weight in gold, and much service and assistance can be paid for by giving flying instruction and occasional rides. The possibility of buying gasoline and oil at commercial rates is another source of saving on a private field.

Whatever the field cost, it should be computed as a part of the annual or overhead expenses.

Example of Cost Computation. With our facts in hand, let us now see how the costs add up. As an example, we shall take a used plane in good condition, perhaps 1½ years old. We can buy such a plane for $1,500, perhaps less. Here are the figures:

Annual Costs (Overhead)

Depreciation	$300
Interest on $1,500 at 6%	90
Insurance	189
Hangar Rent	144
Total	$723 per yr.

Hourly (Operating) Costs

Gasoline 4¼ gal. at 18c.	.77
Oil	.08
Engine	.20
Plane	.15
Minor Accidents (10%)	.12
Total	$1.32 per hr.

Fig. 2 shows how these costs are apportioned.

If we fly our plane 100 hr. during our first year of ownership the costs will be:

Overhead Costs	$723
Running Costs (1.32×100)	132
Total cost for 100 hr. operation	$855
Cost per hour of operation	$8.55

In view of this high cost and the added responsibility, perhaps we had better rent a plane. However, before we do, let us consider operating our plane for 1,000 hr. during the year. The cost will then be:

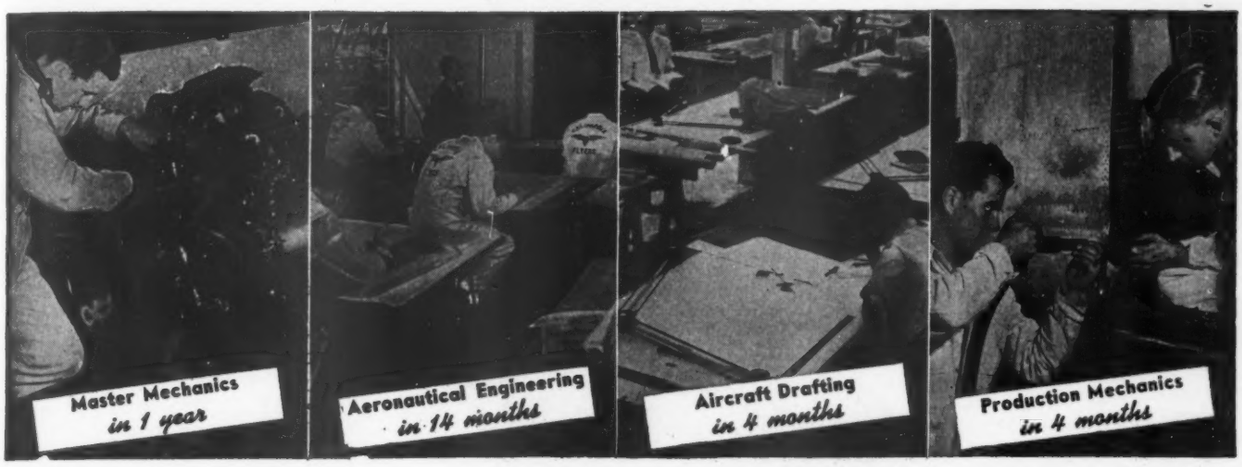
Overhead Costs	$723
Running costs (1.32 × 1,000)	1320
Total cost for 1,000 hr operation	$2043
Cost per hr. of operation	$2.05

Fig. 3 carries out this idea and shows

(*Turn to page 156*)

THIS TRAINING *places* YOU IN AVIATION

(in 4 to 14 months)



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Name_____ Age_____

Address_____

City_____ State_____

Cirrus Engines

(*Continued from page* 71)

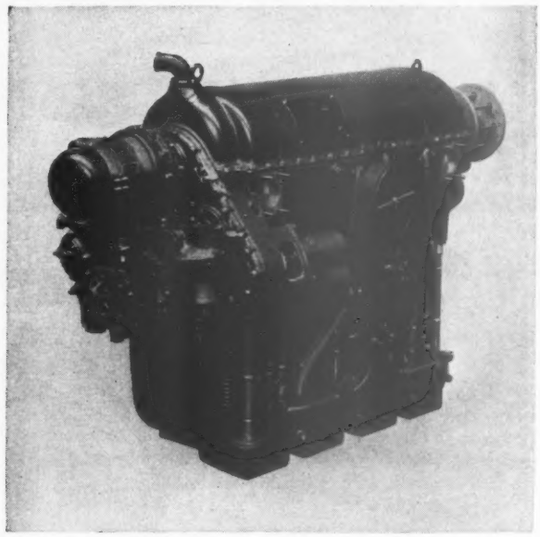
with twin filters mounted on the rear of the engine. The intake manifold is a one-piece casting attached to the cylinder heads by means of eight studs and nuts. The air intake is provided with an Amal flame trap of generous dimensions so that the air can be taken in from inside the engine cowling. Ignition is furnished by two Simms magnetos mounted horizontally one on each side of the crankcase and fitted with automatic timing devices and an impulse starter.

The lubricaton system is well arranged. Delivery of oil under pressure to the bearings and other parts of the engine is provided by a specially designed pump containing three oscillating pistons which is mounted on the rear of the crankcase. This type of pump is said to be an improvement over the gear-type pump particularly when the oil tank is located appreciably below the engine as the pump plungers give considerably greater lift. The oil filters are integral with the pump. The pressure filter consists of a number of conical filters with a common outlet and the suction filters are of the barrel type. All of the oil is filtered before entering the engine and again before it is returned to the tank. No external oil pipes are used on the engine and the pressure leads are carried inside the crankcase.

The accessories are installed with a view to maximum accessibility. They include a B.T.H. electric inertia starter and a B.T.H. 12-volt 60-watt electric generator. Provision is made for a tachometer drive. A cylinder cooling chute and baffle plate are standard equipment with small detachable panels to facilitate the removal of the spark plugs for cleaning. The four engine mounts for attaching the engine in the air frame have rubber bushes.

The construction of the Cirrus Minor basically is the same as that of the larger engine. The chief differences are the use of Elektron for the crankcase, the attaching of the cylinder heads to the barrels with eight studs and nuts, the use of a Claudel-Hobson A1-40 downdraft carburetor and a three-piece intake manifold with a central heater muff, the use of two B.T.H. SG-4-2 magnetos mounted vertically, and the choice of an Amal fuel pump or gravity feed to the carburetor.

The performance of the two engines is excellent and in accordance with present-day requirements. The Cirrus Major has a maximum output of 150 hp. at 2,450 r.p.m. and weighs 325 lb., or 2.17 lb. per hp. The Cirrus Minor develops its maximum output of 90 hp. at a crankshaft speed of 2,600 r.p.m. and weighs 227 lb., or 2.52 lb. per hp. Both of the engines are of the direct-drive type and operate on 70-octane gasoline with a compression ratio of 5.8 to 1. Their b.m.e.p. of 125 lb. per sq. in. is considered quite good for small power plants without a supercharger.



Rear view of the Cirrus Major

Cirrus Minor aircraft engine

Type: Six cylinders, air-cooled, inverted in-line, direct-drive, four-cycle.
Bore and stroke:.....3.74x5.00 in.
Displacement:.....220 cu.in.
Length and area:.....37.8x2.7 sq.ft.
Power output:.....90 hp. for take-off
Total weight (dry):.....227 lb.
Specific weight:.....2.52 lb./hp.
Fuel consumption:.....0.54 lb./hp./hr.
Oil consumption:.....0.017 lb./hp./hr.
Compression ratio:.....5.8:1

Cirrus Major aircraft engine

Type: Six cylinders, air-cooled, inverted in-line, direct-drive, four cycle.
Bore and stroke:.....4.72x5.50 in.
Displacement:.....386 cu.in
Length and area.....42.9x4.2 sq.ft.
Power output:.....150 hp. for take-off
138 hp. normal output
Total weight (dry):.....325 lb.
Specific weight:.....2.17 lb./hp.
Fuel consumption:.....0.54 lb./hp./hr.
Oil consumption:.....0.010 lb./hp./hr.
Compression ratio:.....5.8:1

Cost of Planes

(*Continued from page* 154)

how the cost of flying per hour varies with the number of hours flown for four planes of varying cost. The lowest curve in this series comes close to the lowest cost at which flying time can be secured today. However, even this lowest cost allows for essentials and is computed from the following items:

Yearly Costs

Depreciation	$100
Interest 6% on $400	24
Insurance—liability and property damage	80
Hangar Rent	36
	$240

Hourly Costs

Gasoline—3½ gal. at .14	.49
Oil	.03
Engine	.13
Plane	.10
	$.75

Costs for the operation of any light plane under normal conditions may be closely approximated by the following two formulae derived from the data:

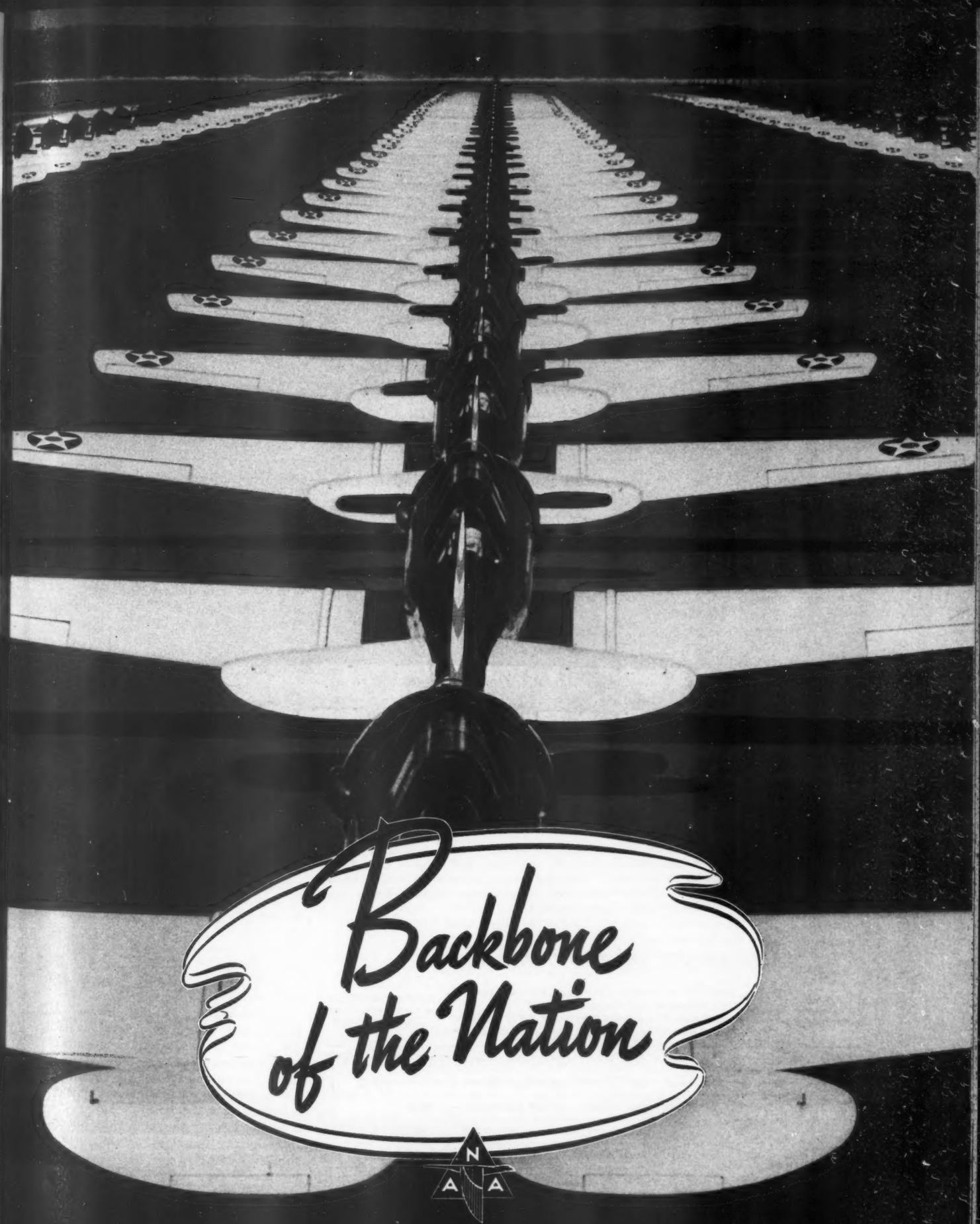
Annual Costs (Overhead) = $300 + cost of plane x .30

Hourly Costs (Operating expense) = Engine h.p. x $.02 to $.025.

A few minutes' study of the figures should convince anyone that the only way to keep the cost of flying time down is to keep the plane in the air. The natural limit on this is the 8,760 hr. in the year. Darkness, bad weather, repairs and all other causes reduce the time available for normal flight to about 2,000 hr. It is unusual for a plane to be in the air for more than 1,000 hr. in a year, which would be an average of 2¼ hr. of flight per day. However, some light planes used for civilian pilot training work have been flown as much as 1,500 hr. in the past year.

Keeping Costs Down. Since the total cost of operating a plane must increase with the number of hours flown, even though the cost per hour is decreasing, joint ownership or some form of flying club is probably desirable to reduce costs to the individual. For example, an individual can own a plane and fly 100 hr. per year for a total cost of $855. Two individuals using the same plane and each flying 100 hr. per year would pay only $494 each. This is a saving to the flyer of $361. Ten individuals using the same plane for 100 hr. per year each would pay only $205 each. Another way of looking at these data is

(*Turn to page* 158)



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North American BT-14s at Randolph Field. Photo U. S. Army Air Corps

Thread Cutting Screws

(*Continued from page 64*)

two screws and one by two rivets. Thus comparisons could be made that would not reflect variation in test conditions.

The vibration test machine was built and equipped to pre-load the test strips, then flex the screw and rivet fastened joints at approximately 5,200 cycles per minute. Tensile loading and amplitude of movement could be varied as may be seen in the diagramatic sketch. (Fig. 1) Biggest surprise came from the results of these vibration tests. Where the average time required for failure was 33 min. for screws against 25 min. for rivets.

Results of shear and axial tension tests were equally impressive as may be observed in the accompanying performance curves (Fig. 2), and the graphic summary of ultimate shear and tensile loads held by the two types of fasteners. Note that average results are considerably better for thread-cutting screws than for aluminum alloy rivets.

In all stress failures, breakage occurred in the held material and not in the fasteners themselves—thus illustrating the holding ability rather than the integral strength of the fasteners.

Galvanic corrosion effects caused by the association of steel screws and aluminum alloy metal were observed and studied. After 250 hours of salt spray, corrosion was noted in all test joints but practically eliminated where the steel cadmium plated screws were dipped in zinc chromate paint before driving.

It is, of course, too early to regard these tests as conclusive. They do show, however, that the advantages of thread-cutting screws in aircraft construction cannot reasonably be disregarded. There is a distinct possibility that these screws with their obvious laborsaving advantages may be made available to aircraft manufacturers who seek a way out of some of the design and operation difficulties presented by blind fastenings.

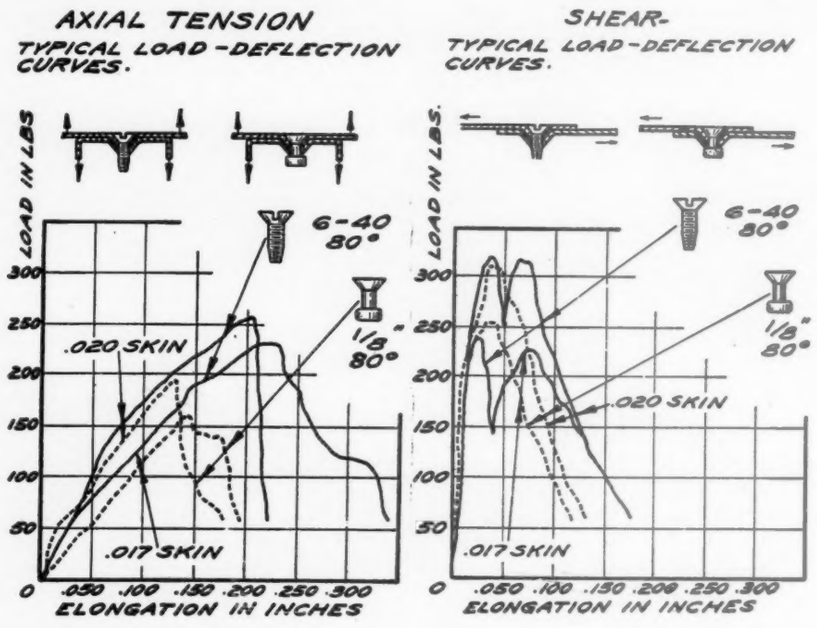
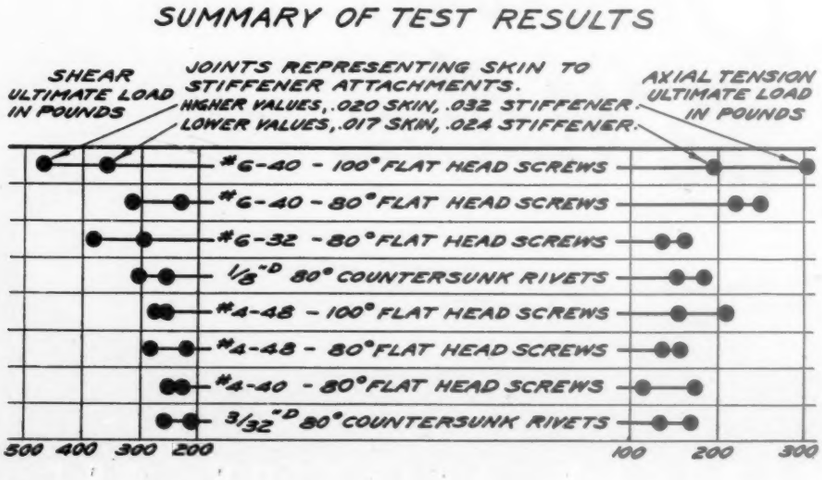


Fig. 2. Table below gives shear and tension loads for several combinations of skin and stiffener. A .020 skin with .032 stiffener and .017 skin with .024 stiffener were used with the corresponding loads as indicated. Fastening these together were various types of screws and rivets listed as shown, with their corresponding results. Above are typical load-deflection curves for shear and tension.


SUMMARY OF TEST RESULTS
SHEAR ULTIMATE LOAD IN POUNDS
JOINTS REPRESENTING SKIN TO STIFFENER ATTACHMENTS.
HIGHER VALUES, .020 SKIN, .032 STIFFENER
LOWER VALUES, .017 SKIN, .024 STIFFENER.
AXIAL TENSION ULTIMATE LOAD IN POUNDS
#6-40 - 100° FLAT HEAD SCREWS
#6-40 - 80° FLAT HEAD SCREWS
#6-32 - 80° FLAT HEAD SCREWS
1/8"D 80° COUNTERSUNK RIVETS
#4-48 - 100° FLAT HEAD SCREWS
#4-48 - 80° FLAT HEAD SCREWS
#4-40 - 80° FLAT HEAD SCREWS
3/32"D 80° COUNTERSUNK RIVETS
500 400 300 200
100 200 300

Cost of Planes

(*Continued from page 156*)

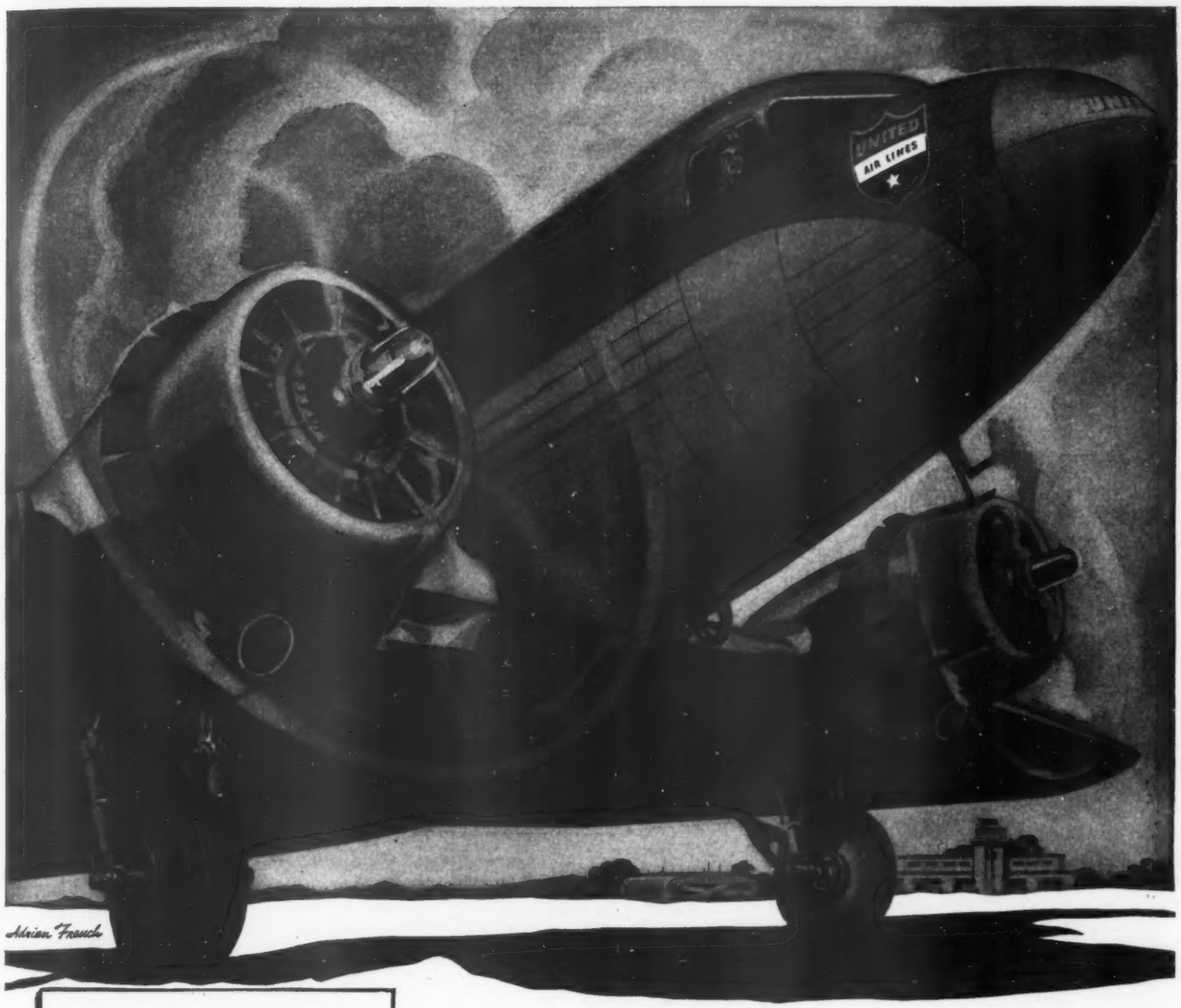
to consider how much flying time a dollar will pay for as the plane use is increased. Figs. 4 and 5 illustrate this clearly.

Planning Necessary. While such a method of plane use as outlined above has advantages in greatly reducing costs, the difficulties of joint ownership must be remembered. As soon as more than one person uses a plane the responsibility for its maintenance and the scheduling of flying time should be vested in one individual.

In choosing the group to participate in the use of a plane it may be well to go so far as to consider working schedules and vacation periods of men forming the group. Only in this way can the greatest use of the plane be secured and costs kept at their lowest.

Since some system of bookkeeping is necessary, the simplicity of coupon or ticket books should be considered as a means of keeping track of flying time. If it is necessary to encourage members of the group or club to fly more, a sliding scale of monthly charges may be used. For example $6 for the first hour flown, $4.50 per hour for the next 4 hr., and $4 for all flying time in excess of 5 hr. for any month.

Responsibility. Private owners of planes may insure their legal liability for injury to the person and damage to the property of others under a liability and property damage insurance policy. Where a plane is owned jointly by a group of individuals, as in a partnership, it should be remembered that any one individual in the partnership may be held personally responsible for the damage caused by the partnership-owned plane. Insurance policies afford ample protection against claims arising from such responsibility up to the limits of liability of the policy.



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Drop Hammer Technique

(*Continued from page* 55)

drop hammer parts are not formed from blanks of the exact required size. Instead, oversized blanks are used, and the finished part is trimmed after forming. This trimming may be done by hand, on the pin router, the shaper, or by other tools. (See Fig. 4.)

Discussion of Drop Hammer Parts

In the following paragraphs are discussed various typical examples of drop hammer parts, the purpose being to give an approximate indication of work that can be handled with Lockheed's present equipment. These examples have been selected from parts in actual production.

The dinghy housing and the cabin door frames are the largest parts produced. The dinghy housing is also the deepest drawing job that is done at present.

Drop-hammer-formed parts that have been produced in the greatest quantity are: Corner Seals, approximately 1,800; Flap Track Fairings approximately 4,000.

Parts that have been considerably simplified from an engineering standpoint are: Cabin door frame, Filler well Doubler, Tail bulkhead.

A part that has proved to be very difficult from a shop standpoint is the dinghy housing.

Design Rules

The following are a number of design rules that have been developed from actual practice. Their observance will facilitate the production of parts and will insure low production costs.

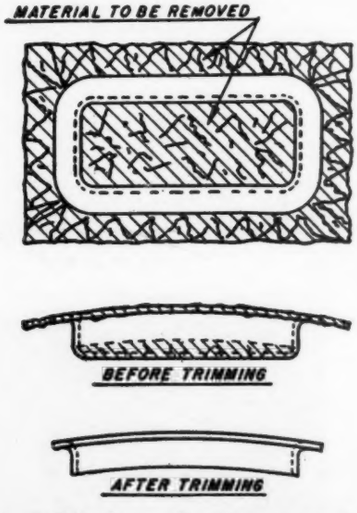

Fig. 4. Trimming a drop hammer part on the shaper.

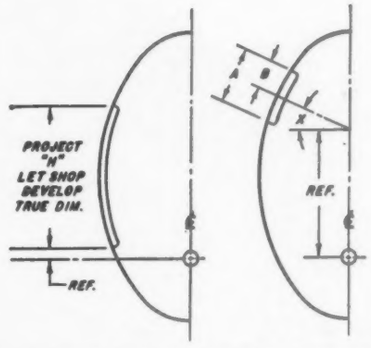

Fig. 5. Basic dimensions of drop hammer-formed parts may be given, allowing the shop to develop the rest.

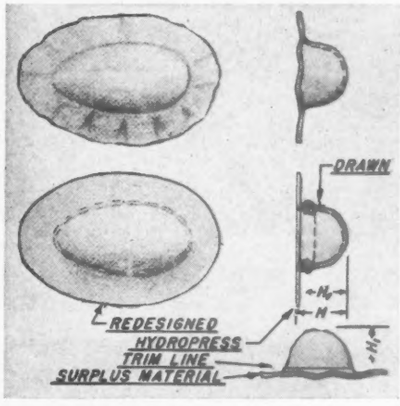

Fig. 6. It is much more practical to attach flanges by riveting, than to incorporate them in the drawn part.

1. Materials

Aluminum and aluminum alloy sheets of all types may be formed on the drop hammer, although the most economical alloys for production are: 3SO, 3S½H, 24SO, and 52S. Stainless steel and similar metals may be formed, provided the metals are in an annealed condition. It may often be necessary to provide steel punches and dies for these harder metals. However, simple forming operations can be done satisfactorily with the conventional equipment.

2. Gages

With reference to aluminum alloys, the most practical gage for drop-hammer-formed parts is .051. Thicknesses under .025 cannot be satisfactorily formed because of their tendency to wrinkle excessively. If the thickness is greater than .064, there will be a tendency of the material to work-harden rapidly. In connection with stainless steel, gages from .008 to .049 may be handled without excessive difficulty.

3. Dimensions

A wide range of dimensions may be handled on the drop hammer. Parts may vary from small brackets up to large units covering the whole drop hammer bed. The maximum size bed on the largest hammer is approximately 3½ by 4 ft. In some cases, where drawing is not too severe, it is possible to use dies that overhang the drop hammer bed. Thus, the over-all length of parts may be greater, although the width cannot be increased. In any case, where this method seems desirable, the production staff engineer should be consulted.

4. Working Tolerances

Work on the drop hammer is definitely not classed as a precision operation. Dies have a tendency to spread with use, causing finished parts to "grow." Therefore, it is impractical to demand close tolerances on drop-hammer-formed parts as in punch press work, or even as in hydro-press work. Generally speaking, 1/32 may be held on the average small part. Chart I gives the approximate tolerances recommended for use with drop hammer parts, according to their respective sizes.

As to tolerances on curvature, the shop should be allowed as much freedom as possible provided that the part will fit and function satisfactorily. Requiring the shop to hold closely to prescribed curvatures results in excessive production costs and should definitely not be required unless there is sufficient justification.

5. Radii

In all cases the largest possible radii should be specified consistent with design requirements. Chart II illustrates the relative size of radii required under certain given conditions and gives approximate radii recommended as governed by the size of the finished part.

(*Turn to page* 162)

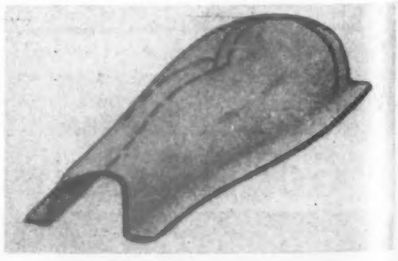

Fig. 7. Open channel forms offer a greatly simplified problem of drawing.

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Crew	3
Engine	*Wright Cyclone G-205A*
Total H.P. (sea level)	*1,200*
Fuel capacity	*320 gal.*
Normal range	*1,250 mi.*
Fuel consumption (cru. speed)	*48 gal. p.h.*
High speed (at 16,400 ft.)	*257 m.p.h.*
Cru. speed (at 16,400 ft.)	*215 m.p.h.*
Rate climb (sea level)	*2,540 ft. p.m.*
Service Ceiling	*28,800*
Weight empty	*6,560*
Gross weight	*10,600*

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Drop Hammer Use

(*Continued from page* 160)

The minimum radius on any drop-hammer-formed part should be equal to at least *twice* the minimum bend radius for the particular metal being used.

6. Dimensioning Drop-Hammer-Formed Parts

Where drop-hammer-formed parts are concerned, too many dimensions may prove definitely disadvantageous, especially in connection with parts involving complicated forming, as, for example, door frames, window frames, sections of fuselages, cowls, etc.

Most of the complicated parts mentioned above are developed from a master form on which the complete surfaces are exactly defined from the basic dimensions of the structure (or from loft templates, obviating the necessity for numerous dimensions relative to contours). Therefore, it may often be feasible to give a reference point on the body of the part (See Fig. 5) as a basis for the development of the most important dimensions, such as width, height, and corner radii of a door frame, etc. allowing the shop to develop the balance of the dimensions. Thus, the designer can avoid spending an undue amount of time in making projections, using complicated dimensioning systems, etc. Also, the shop can proceed more rapidly and produce formed parts that will meet all requirements.

7. Deep Forming

Deeper forming can be done on the drop hammer than can be accomplished on the hydro-press. For example, on the drop hammer, metal can be drawn to a depth equal to the span of the depression, while on a hydro-press, material can be stretched to a depth equal to only one-fifth of the span of the depression. With drop hammer forming, no limit is imposed on drawing by the stretch of the material to the tearing point, as is encountered in hydro-press forming. The limiting factor is the tendency of sheet metal to wrinkle around the area of the top of the die. When a point has been reached where these wrinkles can no longer be taken up by shrinking, further drawing cannot be accomplished satisfactorily. If very deep drawing is desired, this can be accomplished much more easily if no flanges are specified on parts (See Fig. 6.) It is much more practical to attach flanges by riveting, spot welding, or other methods than to incorporate them in the drawn part. (This applies particularly to deep drawn parts). If superfluous material can be trimmed just below the first band (See Fig. 6), then most of the wrinkles can be eliminated. Where flanges are essential, limitations on the depth of draw are most pronounced in connection with cup-shaped or tub-shaped parts which involve the drawing of sheet metal toward the center from all directions. If the part is roughly formed like a deep channel, or if it has open ends, the problem of drawing is much simplified. (See Fig. 7.)

In general, it may be said that the drop hammer is most efficient when used for severe forming. Other methods may be preferable for producing parts having large flat surfaces with slight curvatures.

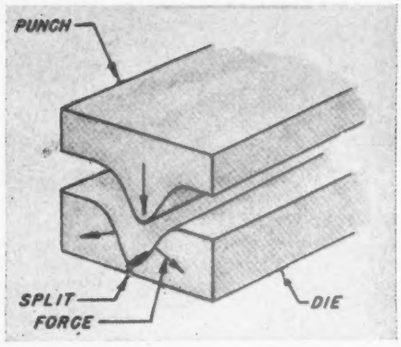

Fig. 8. Wedge-type forms are generally unsatisfactory, since the die tends to split under the impact of the wedge-type punch required.

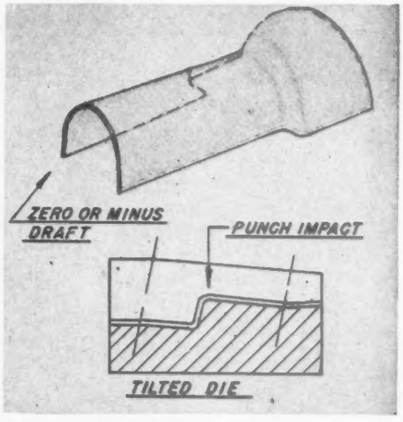

Fig. 9. Reverse draft angles are accomplished by rotating the die from a horizontal plane to an angular situation.

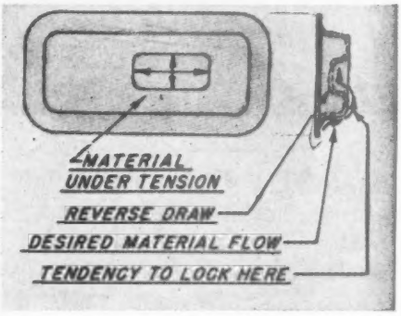

Fig. 10. Reverse draw should be used discriminately.

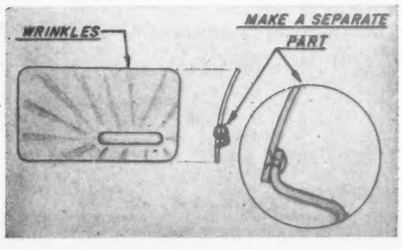

Fig. 11. Deep draws in large formed areas should be avoided.

8. Angles in Drop-Hammer-Formed Parts

Drop-hammer-formed parts (similar to forgings) must usually have a draft angle which is approximately 3 deg. Although the Lockheed shop can in some cases produce parts with practically no draft, it is recommended that such parts be referred to the production staff engineer before release. Occasionally draft angles greater than 3 deg. will be necessary to permit conformity with more important dimensions.

The shape of parts should also be considered with reference to the loads and force acting upon the dies by which they will be produced. Forms having a wedge-type cross-section are generally unsatisfactory, since the die has a tendency to split under the impact of the wedge-type punch required. (See Fig. 8.)

Occasionally, reverse draft angles may be required, and this may be accomplished by rotating the die from a horizontal plane to an angular situation. (See Fig. 9.) Reverse draw (Fig. 10), should be used discriminately. Since flow of the sheet material is necessary to successful drawing, this must not be restrained or a possibility exists that the material will tear. Such parts are subject to continual spoilage and consequently have a high percentage of rejection. Furthermore, the life of dies for such parts is comparatively short.

9. Restrictions on Design

Deep draws in the middle of large formed areas should be definitely avoided. (See Fig. 11.) In order to form a depression of this type, the sheet metal must either be stretched or drawn from the adjacent material. Therefore, wrinkles running radially from the draw center are created, and these wrinkles often run the full length of the sheet, from the center to the outer edges. The elimination of such wrinkles is a very difficult operation and it is much more economical to form the drawn part from a small sheet, subsequently attaching it to the large part by riveting or similar methods.